SIMUL8

Manual and Simulation Guide

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To install **SIMUL8** on your computer please see the installation guide at the back of this document (page 353).

Get-started: read the section "Building your first **SIMUL8** simulation" (page 21).

Visual Thinking
creates software that helps people make better business decisions.

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Introduction

SIMUL8 is a high power, but very easy to use, simulation package.

This **SIMUL8** User's Manual covers:

SIMUL8 - how to use it

Simulation - how to conduct complete simulation studies

First, lets take a look at what simulation is, then we will consider how **SIMUL8** helps us do simulation.

Simulation - Introduction

Simulation lets you explore an electronic model of the project you manage - whether the project is a factory, or a hospital, or an administrative center, or whatever. The type of model it provides is time-based, and takes into account all the resources and constraints involved, and the way all these things interact with each other as time passes.

This means that the model really can match reality - so something you try in the model will behave the same way as it would in the real organization.

With simulation you can quickly try out your ideas at a fraction of the cost of trying them on the real organization. And, because you can try ideas quickly, you can have many more ideas, and gain many insights, into how to run the organization more effectively.

Simulation is also a communication tool. As one of our first customers said: "We don't want to just find the right solution, we want to use it to sell that solution to every one of our staff in our 200 branches".

When you click the RUN button in a simulation model you see the work you do (products, patients, paper work etc.) move around the organization. The clock in the corner of the screen tells you what the equivalent time would be in the real system, and the software automatically collects performance measures as the modeled resources work - so that, you not only see visually what will happen, you can also get accurate numerical results to prove your case.

Definition

Simulation is the process of building and using a time based visual model which emulates every significant step that occurs in a process and every significant interaction between resources in a process so as to gain insight about the impact of potential decisions on that process. The model shows you visually what will happen in the process if you make changes to it and it records performance measures of your system under different scenarios.

Actually different people (working in different fields) define simulation in different ways. For example, in the aircraft industry simulation means flight simulators which help a pilot train to fly a new type of aircraft.

However, we will consider simulation in the business decision making sense described in the definition paragraph above.

SIMUL8 - Introduction

SIMUL8 is different from many other packages because its design is based on some careful research rather than a desire to exploit a potential market. Our main objective in launching **SIMUL8** is to get simulation used so that it can benefit industry and commerce in the way simulation should.

One of the main impacts of the above statement is that the way you use **SIMUL8** is not based on programming or statistical data, but on drawing your organization (with the computer's mouse) on the screen, and only filling in numerical information where *you* need it.

However, you can still use **SIMUL8** for traditional hard number crunching simulation. It is built with the expectation that this is the likely finale of most simulation studies. But our experience (and we have a good deal of simulation experience) is that what people need in a simulation study is:

1. A very quick model to enable them to start thinking about the structure of a situation.

2. To be able to build in numerical information as and when it becomes available but only to the level of detail which is appropriate for the level of investigation required.

3. As the model is used more, and the people concerned start to home-in on detailed plans for changes to their organization, to be able to cope with any level of complexity.

4. To be able to obtain easily understood, but rigorous, performance results from the simulation package.

One and Two above recognize that simulation is a communication and thinking tool, not just an analytical tool.

The Process

You build your **SIMUL8** simulation by drawing it on the screen. You place work centers (machines or desks or people or other facilities which do work) on the screen by clicking buttons and dragging the objects to places on the screen which match approximately with the real organization. You specify the route which work normally takes though the organization by dragging arrows between the objects.

The simulation will run as soon as you have done this.

Other objects are provided to make it easy to represent the way things really work. (For examples we provide "Storage bins (queues)", "Floating Resources" etc. etc.).

Then you click on objects on the screen if you want to add detail.

Initially this detail consists of timing information, routing information etc. But later, if needed, you can control each of the objects using rules entered using **SIMUL8**'s "Visual Logic"

The next section of this manual takes you step-by-step through building a very simple simulation.

Building a first SIMUL8 simulation

With **SIMUL8** you build your simulation model simply by drawing it on the screen.

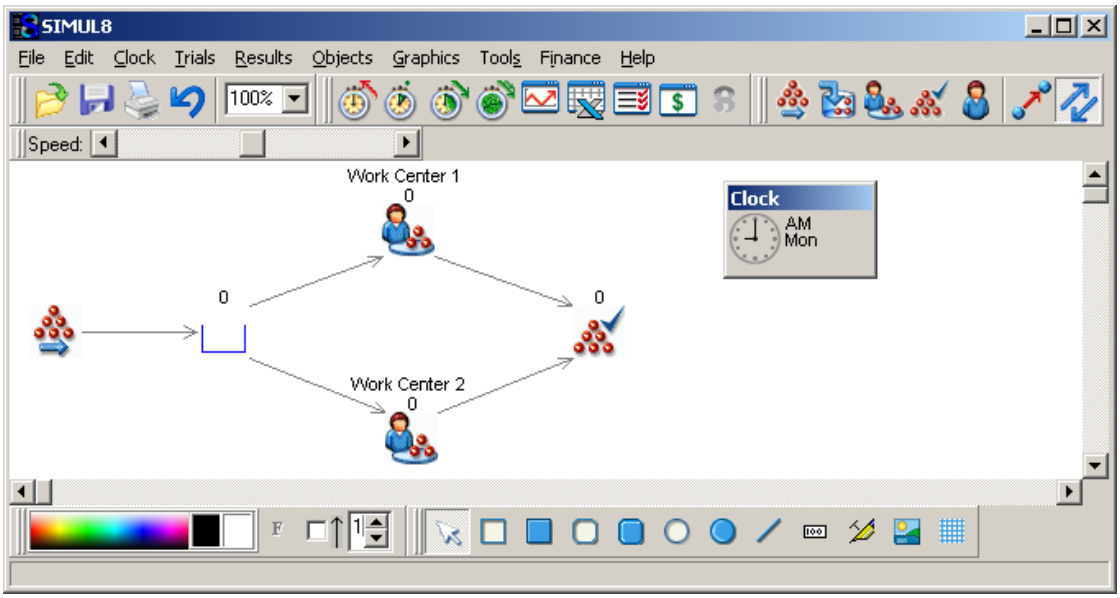
(You can follow this chapter in an on-line tutorial - Click HELP / GETTING STARTED in **SIMUL8**)

We suggest you start with a simulation that looks like the one in the picture overleaf, and then extend it.

However, before we start, a short overview of some concepts:

> When drawing your simulation you are drawing onto the screen a number of simulation *objects*. These are things like *work-centers* (which perform work) and *queues*. These are joined up by *routing-arrows* which describe the default route which *work-items* take as they move through your simulation. Work-Items are simply things which you work on in your organization (like products, or people, or paper work).

Lets try building this simulation:



Click the 'Work enters operation' button ( ) and place the icon that appears somewhere on the screen.

Next click a 'Storage' button and do the same.

Then place just one work center on the screen using the : button (we will copy it in a moment to make the second one).

And finally somewhere where work leaves the system with the : button

SIMUL8 has automatically linked them together for you (the arrows). It does this for simple simulations only. Normally you put the links in (or take them out) by dragging the mouse- See page 94.

You can run the simulation now.

However if you want to put a second work center in (like in the picture above) PRESS and HOLD the "CTRL" on the keyboard and then drag "Work Center 1" to a new location on the screen with the mouse. (This is similar to the way you can copy files in File-Manager).

Now click the RUN button : .

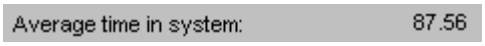
Click the RUN button a second time to stop the simulation.

If you don't tell it otherwise your simulation will run for one week (a 40 hour week). At the end of the week you can look at some results (measures) on how well the system has performed.

For example, double click on the "work complete" icon:

and then on the RESULTS button which will have appeared. The results may differ on different PCs

This will show you how long the items of work which went through your simulation took to get through the system (on average):



Now, all this is dependent on the timing information which is in the simulation (and which so far **SIMUL8** has made assumptions about without asking you!)

SIMUL8 takes this approach because it lets you build a simulation fast when all you are concerned about is using the simulation as a discussion vehicle to get the structure of a situation understood.

When it comes to accurate analysis, we need to put some numbers in.

If you still have the results window on the screen, click the CLOSE or OK buttons to get back to just the main simulation window.

Click on one of the work centers:

You will now see a dialog box which gives you access to an enormous number of parameters and settings which can be used to configure how work is done.

For now, just change the number in the box labeled "Average" from 10.00 to 20.00.

Click the OK button,

Now click the RUN button.

Once the simulation has run, take another look at the RESULTS inside the "WORK COMPLETE" object.

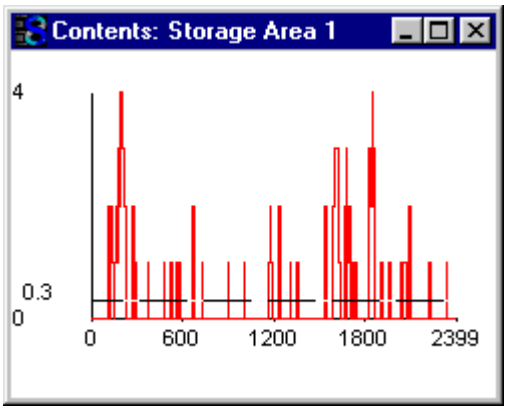
The work took longer (on average) to get through the system - this is to be expected - but simulation has told you HOW MUCH LONGER!

Have a look at some more results.....how long was the queue on average?

Go back to the main simulation window (click CLOSE and OK until you get there).

Now click on the STORAGE BIN:
and click its RESULTS button. Then take a look at its TIME GRAPH:
(Click in the results dialog)

It will look something like this:



An average of only 0.3 jobs queuing - but a worst case peak of 4.

You should take some care about the way you interpret the results and performance measures. You should read the section of this manual on "Simulation: The Technique - a Guide" to understand how to use results that come from simulations.

However, first we suggest you now have a browse through the "Reference Section - The **SIMUL8** facilities" part of the manual.

Printing the Simulation:

The print Button on the Toolbar and the File, Print option allow the simulation Window to be printed or saved to an image file.

To Print the image to a file select the File menu and either the Save as Image File option or the Export option and select Bitmap. This saves a copy of the viewable portion of the Simulation Window to a *.bmp file, and allows editing and insertion into reports.

The image can be Previewed and the orientation of the page altered by using the Select Printer and Page Layout option.

Overview of using SIMUL8 for building simulations

The purpose of this section is to give some guidance and insight into the facilities which can be used when building rather more majestic simulations than the one mentioned in the previous section!

SIMUL8 contains a wealth of facilities which are described in detail in the help file and the reference section of this manual.

The current section gives an overview of a few of these facilities that the experienced simulation user might want to know about before tackling significant simulations.

Main Concepts

(This discussion is repeated in more detail at the start of the reference section).

A **SIMUL8** simulation consists of "**Objects**" (things like queues and work centers) on the screen with a default structure (routing) between them and "**Work Items**" which flow around the simulation - these "work items" are the "jobs" which are done in your organization.

Work items come in different varieties (if you want). All simulations have a default "Work Item Type" - but you can create as many more types as you like.

Work Items can have labels (like "illness", "age", "history" if your work items are patients in a hospital). Each individual work item can have different values for each of its labels. Values of labels can be changed and used by work centers.

An important type of "Object" is a "Resource". These are "floating resources" which can be used at work centers. For example, if work centers are machines, they might need resources called people to operate them. Resources do not have to be available for work all the time - you can describe shift patterns to which they can work. Work centers do not have to use a fixed number of resources to work - they can be set to work faster if more resources are available.

All objects and work item types can be given their own name. We recommend the first thing you do when you start building a new simulation is to rename the default work item type to something more relevant to your environment. ("Work Item Type 1" is not a good name for "Customers"!).

Display

SIMUL8 lets you build a simulation that is heavily customized to your own situation.

Most of the examples shown in this manual use standard facilities However, you can easily create your own images to replace or enhance those provided as standard.

There are many example images provided in the **SIMUL8** directory on your computer.

Objects do not actually have to be displayed - you can make them invisible if you want. This often done if you want to hide a complex part of your simulation which might not be important to a particular aspect you want to review today. (Although in a large simulation you are likely to use sub-windows to do this). It is also used to hide a "synthetic work center" - one which controls routing but does not physically exist in the real factory (it is just a control rule).

You can add to your simulation's display lines, text and graphics which are not part of the actual structure of simulation logic, but instead are there to add to the realism of the simulation, so that it looks like the situation being simulated.

The default display shows only the numbers of work items within each object and the work items as they travel between objects, but you can select to display much more information about each object, and the work items themselves as they travel around the simulation. To achieve this, click on the relevant object, then the GRAPHICS button which will have appeared.

Tailored Interactive Aspects

If you want to set your simulation up as part of a regularly used system in an organization, it is sometimes better to create your own interactive facilities specifically tailored to the environment concerned. You can do this by creating dialog boxes of your own (using Excel/Visual Basic) and controlling the **SIMUL8** simulation from Excel/Visual Basic. There are examples provided which show how to do this.

Simulations with similar parts

If your simulation is likely to consist of a number of similar segments (for example 5, more or less similar, production lines, or a group of 4 operating theaters with broadly similar procedures) then our experience with **SIMUL8** has been that it is quickest to build one of these sections first and then simply copy this section as many times as required. The on-screen copy facility lets you drag a box around many objects and then simply drag the box (with CTRL pressed) to copy them and their structure.

Similarly (but on a smaller scale) if you have several work centers which work the same way, it is worth setting up one, and then copying it to create the others.

Named Distributions are useful for speeding up the creation of simulations (and later changing them). A "named distribution" is simply a statistical distribution (say Normal with a mean of 12.4 and standard deviation of 2.1) which has a name (say "Machine Cycle Time"). All your work centers which are machines of this type can then use this distribution - and if you need to change the speed of your machines you can simply change the parameters of the named distribution.

Simulations within simulations (Sub-Simulation Windows)

A feature which is particularly useful for large simulations is being able to shrink part or parts of the simulation into sub-windows. You can drag a box around part of the simulation and the click the right mouse button and "make sub window". All the objects in the box going to a new simulation window which can then be closed and it becomes a single icon on the screen. You can have sub windows within sub windows - to any level of depth, and have any combination open or iconic, to watch any aspects of the simulation you like.

This means you can create a simulation of a whole organization, with multiple factories, each containing multiple product lines, each containing multiple cells, and view two cells in different factories and the impact on an organizational variable at the same time.

If (during your project) responsibility for one of the sub-sections changes to a different department you can simply drag one sub-window into another on the screen.

Simulation Structure

With **SIMUL8** you build a default structure (routing for work items) into your simulation, however, your work items can take different routes. This is controlled using the Routing In and Routing Out facilities which tell work items where to go when they enter or leave a work centers. The routing in and out dialogs also let you control a wealth of other features which affect the work center's choice about work to do and what to do with it.

External Data

Although the interface to Excel/Visual Basic is in **SIMUL8** to let you control the logic of your simulation you can also use it to simply provide external data to your simulation. This lets you quickly use data that is in a spreadsheet (or can be got into a spreadsheet) in your simulation. The facility works by letting you create what **SIMUL8** uses as a "distribution" but which is actually data in EXCEL. The data which **SIMUL8** uses (where there might normally be a statistical distribution) actually comes from a column of cells in the spreadsheet.

Zoom

The simulation window (or any of the sub-windows) can be zoomed so that you can easily get an overview, or look at detail, when required.

Business Process Re-engineering

Work centers normally work on jobs "one at a time" modeling each work item as a completely unique item in the model. Every one can be individually distinguished so that you can model any situation in a great deal of accuracy. However, some situations are better modeled with a slightly different approach. BPR applications (where you want to model high volumes of transactions) do not need to model every individual piece of work. It is usually better to categorize the work and think in terms of number of items in each category. The High Volume switches in **SIMUL8** let you automatically switch individual parts of your models into this mode when you need. (Fast Moving Consumer Goods (FMCG) applications can also benefit from use of this facility.

Documenting Models

Document your **SIMUL8** model by using MEMO buttons in object dialogs and by adding notes to the model itself (File / Model Properties).

You can create a formatted text file which documents the entire state of the model using File / Documentation. This file can be inserted into word processing documents (as part of your report) or printed for detailed checking of the model.

Visual Logic

Visual Logic (VL) is **SIMUL8**'s logic building environment. In a simulation of significant complexity you will want to add your own rules for deciding how to process work. VL lets you add very detailed logic to control the operation of your simulation. It is naturally structured at a number of levels to allow you to quickly access the logic used in a particular part of the simulation and also to easily see the logic of the rules you have entered. A guide to Visual Logic starts on page 209.

Information Store

The Information Store holds **SIMUL8** "Global Data Items". These are variables which can be used in Visual Logic. They can be single numbers or "spreadsheets" (a matrix of data), text, of pointers to **SIMUL8**'s simulation objects.

When the **SIMUL8** RESET button is pressed the data item's current value will be set to the value in the On Reset box.

As Spreadsheets have many values you need to click the VIEW button to see the values in a spreadsheet. Spreadsheet values are not changed on RESET.

In programming terms it works just like an array, but visually it is like a spreadsheet.

To change values in a spread sheet simple type the new values.

To copy/paste the entire spreadsheet to/from other **SIMUL8** spreadsheets or other packages use the COPY/PASTE buttons in the spreadsheet dialog. (Using CTRL C and CTRL V will copy/paste the currently highlighted cell).

For more about the information store see page 177.

What Next

This is designed as only as a very brief overview of a few aspects of **SIMUL8**. We strongly urge you to have a browse through the reference section of this manual (or the **SIMUL8** Windows help file) to find out more about the **SIMUL8** facilities before you embark on building a large model.

Simulation: The Technique - a Guide

The main purpose of this section is to enable you to understand and make sensible use of the results which you get out of **SIMUL8**. However, it would be wrong to convey to you the idea that simulation starts with building the model and ends as soon as you get the results.

For this reason, this section covers rather more than just getting the results out of the model. It attempts to convey some guidelines on the **whole process** of conducting a simulation study. You will however find specific sub-sections (h & j) which do deal with the results of model runs and how to interpret them.

The rest of this section is divided into a series of steps, but in practice simulation is not done in a series of steps. Simulation is much more of an iterative process, cycling around until the problem is dealt with. Nevertheless, here we have described it as a series of phases to enable you to see the elements which you need to include.

This is written from the point of view of someone undertaking a consultancy role. Some of the steps are obviously not necessary if you are building a model for your own use - but it is still perhaps interesting to consider them because the existence of these steps highlights one of the major benefits of building models for yourself!

(a) Listen

Listen to your client to find out what issues concern them and how their factory (or what ever the system is) operates. Their thoughts on what concerns them will give you a good idea of what variables are important to model in their factory.

At this stage you might, of course, decide that simulation is not the way to help the client! - but, assuming you do not reach this conclusion.....

(b) Level of Detail?

Think about the level of detail that it would be appropriate to build into the model. For example, do you need to include every part of every operation at each machine in the factory, or is it more appropriate to simply model the output of whole departments and how they interact with each other? Putting too much detail in a model means it costs more of your time to build and can also cloud the issues which the decision maker is interested in.

(c) How Broad?

Think about how wide to make the model. Can you limit the boundaries of the model to the factory itself, or do you need to also include the systems which affect supply of raw materials to the factory?

(d) Build Rough & Ready Model, then Refine it

As quickly as possible build a rough and ready simulation model (it doesn't matter if some data is missing or if it does not run properly) and take it to show your client. Experience has shown that even static drawings on a computer screen can do good job of getting your client to understand (i) more about what it is they will get from you and (ii) what aspects of the conversation, (a) above, have been misunderstood and (iii) what aspect of their worries are different now that a consultant has put some structure on them.

This phase (d) is much more important than it may seem. Experience is that the consultant's first idea of what simulation model is appropriate is never much like

the simulation model at the 'end' of the study. This is not because the consultant was necessarily wrong, but because the client's needs evolve throughout the process.

It doesn't matter how rough and ready the model was because you now have to start again!

(e) Work Closely with your Client

Having built a more robust model you now need to start working more closely with your client. (In fact, with the types of software becoming available now, it is possible for all the stages above to be part of one session with the client).

It is especially important to work with the client because doing simulation is like a journey of discovery with numerous dead ends. You will try many experiments and learn a lot about the way the factory operates and could operate under different circumstances. If your client is not engaged in this journey of discovery then they will not understand how you have reached the end result. This means that implementation of anything other than an obvious solution could be difficult.

We will look more at how you build models in the section below on simulation technology, but it is important to realize that there are two key, but separate, skills in this model building process.

1) Being able to use the software to build the model.

2) Being able to design the display for a model which highlights the important issues to you and the client without clouding the issues with information overload.

The second of these is not easy to learn but as you read the rest of these tutorial you'll get a feel for its importance and what is likely to affect its success.

The phase above (e) breaks down into many sub-steps - each of which are described next. This phase continues until the client feels they know what is best to do: In other words until the problem is "solved".

(f) Running your Model

You will already have been running your model quite a bit by now (by 'running' we mean setting the clock going and see the products moving around the factory) and you may have gained many insights into how the factory works and what changes could be made to improve it. However, it is very important to ensure certain key steps are taken to ensure validity of these discoveries.

(g) Verification

The first of these steps is to verify that the model is running in the same way that the real world would work in the same circumstances. In theory there is a need to do this every time you make a change to the model, but clearly this would be impractical. If the simulation is a model of an existing factory (or other system which actually exists) then this verification stage is just a matter of ensuring the model behaves as the real factory currently does. So you can put some actually customer orders (for example) into the model and see if they are handled in the same way and in the same time as they are in the real factory.

The only way to verify a model of a new factory (which does not yet exist) is to carefully experiment with the model, watching (both the animated screen and the performance measures) to see if the changes you see are reasonable in the light of changes you make to the input to the model (such as demand, numbers and

speeds of machines etc.). There is a methodological problem here because clearly if these changes were known, or expected, there would be no need to build and use the simulation model in the first place. Nevertheless, careful examination of the model's behavior will allow you to see and remove most mistakes or misunderstandings in the model building.

It is very easy to omit this stage in the excitement and urgency of trying to help your client find a solution. Omitting it is also one of the easiest ways to loose a client's faith in your work when they see the model show some result which is not only intuitively wrong but proves to be caused by a mistake!

(h) Warm Up Time

You may need to find a suitable 'run-in' or 'warm-up' time for your model. Models of factories usually need a warm-up time because your model is likely to start empty (no products at any of the machines), but real factories do not start each week without any work-in-progress! A situation where you would not need a warm-up time in a simulation model might be when you are simulating the start up of a new factory, where you happen to be interested in its first day's operations, or where you are simulating a situation which starts each day empty: like a shop, or a car park, or an airport. However, even in these circumstances you would probably want to separate off the results you get during the early part of the day from the results under peak conditions because knowing the 'average' performance of an operation which never works under 'average' conditions is probably not worthwhile.

Most simulation packages contain facilities to set a 'warm-up' time during which results are either not collected, or which can be separated off from the main results collection time.

But how to you decide how long to make the warm-up time? There is a simple procedure for this.

1) Decide what measures of performance are of interest to you. For example you might be interested in the number of products leaving the factory, or the utilization of a machine or the length of a queue. If there is more than one then you might want to carry out this procedure for some, or all, of the measures which interest you and use the longest warm-up time indicated. Lets just assume you are interested in the number of products leaving the factory.

2) Run the model for a short period of time. The amount of time you run the model for is rather dependent on what you are simulating but if the total time you wanted to run the simulation for was, say, a week (see below for how to decide this) then you might make this "short period of time" an hour. It needs to be an amount of time in which you might expect to get a few products out of the factory. Anyway, having run the model for, say, 60 minutes, record the number of products which have emerged from the factory. *This will almost certainly be zero for the first 60 minutes!* This is because of the nature of the need for a warm-up time. No products will have reached the end of the factory yet!

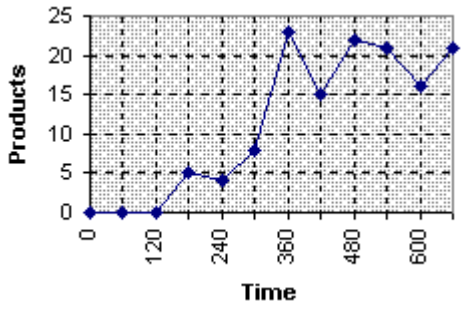
3) Run the model for another 60 minutes (or whatever time you have chosen) and record how many products left the factory in the second 60 minute period. i.e. the number which emerged *between 60 and 120 minutes - not the total at the end of 120*. Keep doing this and you should end up with a table looking something like this:

Time	Products
60	0
120	0
180	5
240	4
300	8
360	23
420	15
480	22
540	21
600	16
660	21

This is the difference between the total output after 180 minutes and the total output after 240 minutes

This is the difference between the total output after 240 minutes and the total output after 300 minutes

which you could plot in a graph to make it easy to see what is happening:



If you plot the graph as you collect the numbers you will be able to see when you have gone far enough. In the example above we can see (by

the time we get to simulated time 660) that there is a fairly distinct difference between the figures prior to time 360 and the figures after time 360. So before time 360 the simulation model was still 'warming up'.

Obviously you will not expect a completely steady line after time 360 because simulation matches reality - and you cannot expect completely steady output from a real factory. The simulation is using random numbers (mentioned above) to emulate the variability in the real world (e.g. for the time a machine takes to weld each box), so you would expect some variability in output. There might be some variability even if the simulation model contained no randomness. This will be discussed later.

This example has been deliberately made clearer than often occurs. Quite often the performance measure in which you are interested never looks at-all stable. Sometimes during the warm-up time the measure you are interested in is very high, sometimes it is very stable - and becomes unstable once the model has warmed up.

You will have to make a judgment when you look at the figures (and a graph) about how much warm-up time to allow. The principle is simply to ensure that the model is not in some atypical start-up state caused by the model starting empty.

4) Once you have determined a warm-up time it is worth adding about 20% to it as a safety margin and then using this warm-up time for all your analysis of the model unless the structure of the model, or the data in it, gets changed significantly. Strictly speaking you ought to recheck the warm up time every time you change anything in the model (even the random number streams) - but in practice this would take more time than is usually available! The only harm in making the warm-up time too long is that it can take up a lot of your time when you are running the model.

Significant changes to the model might affect how long it would take to warm-up, so you might need to repeat the above process.

(i) Visual Exploration

This is the most important step in undertaking simulation.

Traditionally the next stage in using simulation was to design and perform a series of experiments with the model to see how the factory could be improved. Details of how to do this are in section (j) below. However, a much more important step in doing simulation (and one which only became possible when simulation became Visual and Interactive) is to explore the model visually with your client. This enables both you and your client the opportunity to gain an understanding of how the different parts of the model interact with each other, how the performance measures can be affected and to gain insights into how the factory can be changed and improved.

This 'Visual exploration' is done by running the model and watching the products move around on the computer screen. You can, for example, see where bottlenecks build up, you can see under what circumstances these are worst. By changing the model and watching to see the effects of these changes you can gain a knowledge and understanding of the way the system behaves. You can get to know its 'character'.

Of course, exploring a model visually like this is not a rigorous or scientific testing procedure and should always be followed by some careful tests (see (j) below) but it is much better at giving insights into how to improve the factory (or other system) than a series of controlled experiments.

(j) Accuracy of Results

The procedure described here can be handled for you, fully automatically by **SIMUL8**, but it is described here so that you can fully understand to principles involved.

Once some insights have been gained it is important to test the resulting ideas, especially if there are a number of competing ideas and it is difficult to see visually which is best. Remember that a simulation (usually) contains random numbers and if you are simulating a week's production when you explore the model visually, you may be seeing results which apply only to one week (perhaps a lucky week when few of the machines broke down!). A different week might give you slightly (or very) different results.

This procedure described here gives you a step-by-step way to ensure your results are valid. Even if you do not feel a need to go as far as calculating the statistics, you should do the first part and run the simulation model with a number of different set of random numbers.

When using most simulation packages, if you set the time clock back to zero and re-run the model you will see exactly the same things happen on the screen, in the same sequence as the last time you ran it (despite the fact that the model contains random numbers to emulate 'real life'). This is because simulation packages use 'pseudo random numbers' which are generated mathematically and simply appear to be random. Each time the random numbers are re-started, the same sequence of numbers will be generated. This is very useful because it means you can re-watch a model several times to understand exactly what is happening, without the issue being clouded by the random numbers changing each time.

All simulation packages allow you to change the random numbers so you can also see what happens when the random numbers are different. They do this by

allowing you to set the 'stream' of random numbers which will be used. Most packages have many thousands of 'streams' of random numbers built into them so there is no limit on the number of different weeks you can simulate in the factory.

But wait a moment - why are we only simulating a week's production? Why not a year, or an hour? What is the right length of time to simulate? The answer is simple. Simulate an amount of time which makes sense to your client in terms of the performance measure you are using. For example if you simulate the factory for a year and report to your client that you expect the factory to produce 14,500 boxes in a year this might be useful information in itself but might hide the information that any given week's production might be as low as zero or as high as 500. Conversely, your client may be unconcerned by information about the output in any given hour. Choose a time which makes sense to the client. The decision about what time to choose will become clearer when we see (next) what we will do with the information we get.

Lets assume we choose to simulate the factory for one week at a time and with each random number stream we get a different number of products completed by the end of the week. This information can be really useful to your client for making decision with - but it has to be presented in a useful and valid way for it to be of genuine use. This section is all about how to do this.

Once we get to this stage of a simulation study we are normally doing these runs and recording the results because we want to compare two or more alternative decisions which we cannot easily distinguish between visually. Lets assume we have two alternatives and we have run the simulation 30 times for each of these alternatives. For each run (of a week plus warm-up time) we have used different random numbers and obtained the following output figures:

Number of products leaving the factory in 30 different weeks

(30 different random number streams).

Alternative One	Two
293	261
274	264
196	230
254	287
203	287
228	316
234	285
228	257
300	273
210	334
234	242
216	320
218	301
315	292
239	288
246	271
189	274
220	285
229	253
259	265
273	239
265	298
248	223
280	319
232	235
212	260
238	225
300	188
287	246
254	298

The results for alternative one are as low as 189 and as high as 315 with the figures for alternative two being 188 and 334. Which is best? The averages for the two alternatives are 245.8 and 270.5, so perhaps alternative two is best. There is so much overlap between the two, perhaps there is not really any difference between the two alternatives. Can your client really justify spending the extra £1million that alternative two will cost? What if the next 30 weeks (random number streams) average out the other way around? What will the genuine long term average really be?

We could do more many more runs of the models but in practice running a simulation model of a complex factory for even one week can take a long time,- and your client may not be able to wait.

A simple statistical procedure can help here. With limited time to do a limited number of simulation runs we cannot given our client a precise long term average, but if we could tell our client what range we expected the long term average to be inside this might be good enough.

In addition to the information we have so far we could calculate the standard deviation of the individual results:

	Alternative	
	One	**Two**
Average:	245.8	270.5
Standard Deviation:	33.1	33.3

But this only tells us the variability of the *individual* results. We are interested in how safe our *average* figure is. If we had time to do another batch of 30 runs,

would its average be different? If we did 30 batches of 30 runs what would the variability of the averages be?

Fortunately for us there is a statistical relationship which applies here which provides a method of predicting the standard deviation of the *averages* from the standard deviation of the *individual* results - which we have just calculated.

Standard Deviation of Averages =

Standard Deviation of Results / √Number of Results

In our case:

Standard Deviation of Averages = 33 / √30 = 6

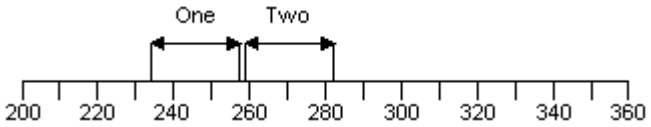
We can now calculate confidence limits for our average to report to our client.

As 95% of normally distributed numbers are within 2 standard deviations of their average then:

95% confidence limits for our average = Average +/- 2 x 6
= 245.8 +/- 12
= **233.8 to 257.8**
for alternative **one**
and
= 270.5 +/- 12
= **258.5 to 282.5**
for alternative **two**

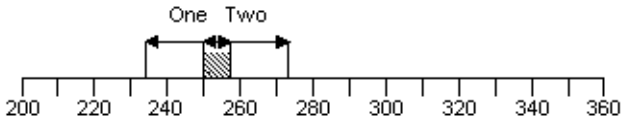
This means that we can say we are 95% confident that the true average for alternative one lies in the range **233.8 to 257.8** and also that we are 95% confident that the true average for alternative two lies in the range **258.5 to 282.5**. So (again with 95% confidence) alternative two will produce more boxes in the long term (but not every week!)

A picture of this can be useful:



Showing this type of picture to your client can help understanding especially if you change the numeric production count information into profit or cost. The above picture shows that it is *just* possible to distinguish (statistically) between these two alternatives.

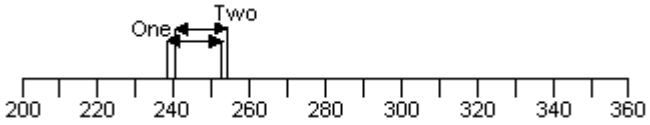
Of course the picture might show this:



An overlap between the two ranges in which case:

1) You **cannot** distinguish between the two alternatives. It is not reasonable to report any difference between them to your client because the average for alternative one could be as high as 257 and the average for alternative two could be as low as 254.

2) You could do more runs because (take a look at the way the range is calculated) the larger the number of runs the smaller the predicted standard deviation of the averages: so the smaller the range. Of course this does not mean the two ranges will definitely separate if you do more and more runs - it simply means your figures are getting more and more accurate. You may move towards something like this:



If this happened it would show there is no difference between the alternatives.

It is rarely necessary to do as many as thirty runs. If you do five runs and then do these calculations you will get an idea as to whether five is enough or whether you will need to do more. Even as few as five can be enough - see the note on statistical theory below.

To summarize the procedure:

1) Do five runs of each of your alternatives, each run using a different random number stream.

2) Calculate the average and standard deviation for each of your alternatives.

3) Calculate the 95% confidence limit ranges for each alternative = Average +/- 2 x Standard Deviation / √Number of Result

4) Draw these up on a picture like the one above to see which alternatives can be distinguished from each other, possibly changing the data to something more meaning full to your client (like £ or $).

5) If ranges overlap do more runs to see if they separate.

A bit of statistical theory: This procedure only works if we know the averages are going to be 'normally' distributed. If we have at least 25 runs to calculate our average then this will be the case but fortunately for simulation users this is usually the case for smaller numbers of runs because the average will be normally distributed if the individual run results are normally distributed. These are (usually) normally distributed because they are, themselves, the combination of a large number (more than 25) individual events (the times between products leaving the factory). A statistical theory called 'central limit theorem' says that any number which is the total (or average) of a large number of other numbers will be normally distributed, whatever the distribution of the original numbers.

(k) How much of this do you need?

The final point here is that you might not get very far through the above phases when doing a simulation study. One of the most important things to realize about simulation in practice is that much of the benefit of simulation comes from the model building phase of the study. The act of building a simulation model causes you to have to ask your client many questions so that you can gain sufficient understanding of the process to build a model. This questioning process has the benefit of structuring in both your and the client's mind many thoughts about the process which had not previously been pulled together. The simulation model then acts as an understandable piece of documentation about the process. It is a 'document' which is extremely easy for most people to understand (being a moving picture of the process).

We realized this quite early on in the days of Visual Interactive Simulation when we noticed that clients were very keen for us to build models for them but often before we were ready to formalize the experimentation process they wanted the model changed. The act of building the model itself was sufficient in some cases to enable the clients to see a new way of operating the plant which they wanted to see tested in the model.

The consequence of this that you will spend most of your time in the early steps of the above process and only dip into the more technical steps occasionally. It also means that the model building stage needs to be relatively easy and quick if you are going to be able to help your client and if your client is to be involved in this process.

Conclusion

SIMUL8 has been designed specifically to match with the above recommended way of conducting simulation studies. In particular it recognizes that a crucial aspect of simulation studies is being able to build and change models very quickly - so that the thinking process (the process of gaining insights into how a system can be improved) is not interrupted.

Reference Section - The SIMUL8 facilities

The Main Concepts

Structure of your model

A **SIMUL8** Simulation model is made up of OBJECTS in a structure. Work Items (work to be done in the operation you are modeling) travel through the structure with objects controlling their flow.

The structure is represented on the screen by a number of objects and lines joining these objects.

A great deal of detail can be placed behind this structure. This makes it possible to use **SIMUL8** at a strategic level, and at a detailed tactical level, as required.

See the "Building your first **SIMUL8** model" for a first view of a model structure.

Important Terminology

Two fundamental concepts underlie most model building in **SIMUL8**:

Objects and Work Items

However, before we look at these we will describe where you will see them.

Simulation Window

The simulation window is the main representation of your simulation model within **SIMUL8**.

The contents of the window are kept constantly up-to-date so that you can see what happens in your model as the simulation runs. From this you gain insights into how the ideas you have about your system work and how they can be further improved

You create your model in this window by drawing a picture of the decision system you want to model.

Each icon in the simulation window represents an object in the simulation model (or an icon can also represent a simulation sub-window because your model can exist at a number of different levels).

To inspect the detailed parameters of any object on the screen, or to look inside any of the sub-windows, simply click on the object. Inspecting the object also lets you look at its performance results (collected as the simulation model ran).

Moving in the simulation window you will see the work items which are flowing around your model.

Simulation Objects

An **OBJECT** in **SIMUL8** is something in the simulation model which you normally draw on the screen and which is normally involved in the work done in the system you are modeling.

The **SIMUL8** simulation objects are:

- Work Centers
- Storage Bins (Queues)
- Resources (People and other items required to do work at Work Centers)
- Work Entry Points
- Work Exit Points
- (Plus other objects available in plug-ins)
- (Plus Components your can build and add to **SIMUL8**)

Drag and Drop objects from the Build Tools Toolbar onto the Simulation Window.

Typically the work done in your system will be simulated by it going through a number of objects which are on the screen, but they can be invisible, and some types of object (e.g. resources) are "used" at other objects (e.g. at work centers).

All simulation objects have names (for example "Fitters", Work Center 1", "Xray Department" etc.).

The items that flow through the **SIMUL8** simulation are called Work Items.

Work Items

A Work Item is the work which is done in the organization being simulated. Work Items flow through the simulation, being stored in Storage Areas, and acted upon by work Centers. Examples are:

Patients in a hospital.
Invoices in an Accounts department
Products in a factory.

Individual work items flow through the work centers (and other objects) in a simulation model.

Each work item is of a "type" known as a "Work Item Type".

Work item types (and therefore all the work items of that type) may have "labels" attached to them. All work items of the same type have the same labels attached to them **BUT** the values in the labels for each individual work item may differ.

For example: a work item type called "Patient" may have a label called "illness" which may be set to 1 for some patients (for "minor"), 2 for some patients (for "serious") and 3 for others ("life threatening").

There is a standard image which is used to display a work item on the screen (the **SIMUL8** #8 ball) but each work item type can have its own default image, and individual work items can have their own individual images changed as they flow through work centers.

Important Images on the Simulation Window

Work Enters Model Object

This object is a "list of work to be done" in the model. Usually it simply describes the average time between items of work entering the model. But it can, for example, contain a list of work stored in a spreadsheet.

Storage Bin (Queue) Object

This icon represent a **queue** in the model (in the simple example here it is shown as a static box, but it is more usual to display it as a queue - showing the work items in the queue as they move through the simulation model). It can be changed using the graphics button in the storage bin's dialog.

Work Center Object

This icon represents the most important type of object in most SIMUL8 models - the places where work is performed.

Work Exits Object

This is where work is declared as "finished".

Work Flow Arrows

These indicate the default path for items of work moving through the simulation model.

Draw them by dragging the mouse from one object to the next *while holding down the* ***SHIFT*** *key on the keyboard.* (You can also use Route Drawing Mode to draw them without the SHIFT key - see page 94).

Contents Count

This number indicates the number of work items in this object.

The value is updated continuously as the model runs.

It can be hidden using the GRAPHICS buttons in the object dialog boxes.

Work Centers

A Work Center is a place where work takes place on Work Items.

Work done at work centers usually takes up time and sometimes requires the availability of resources. At a work center a work item may be transformed in some way (perhaps by changing one or more of its labels).

After the work is done the work item may be sent on to another work center, or one of a number of different work centers depending on routing rules which can be specified.

To create a work center click the create work center button and then click where you want the work center on the simulation window. You can also drag and drop the object while holding the left mouse button down.

To move a work center: drag it on the simulation window.

To inspect or change the work center's parameters: click on the work center on the simulation window.

To copy a work center: drag it on the simulation window with the CTRL key pressed down.

To link a feeding object to it, drag from that object to the work center with the SHIFT key pressed down.

To link from the object to another, drag from it to the object it feeds with the SHIFT key pressed down.

As with all other simulation objects, if you want to access its parameters, simply click on the work center on the screen. When you have clicked on the work center you will be shown the work center's dialog box. This contains some of the parameters, and buttons which access the many other parameters available.

Each individual work center can be documented using the memo button. The image used to display the work center on the screen can be selected from disk or drawn using the graphics button. The image used can be different when the work center is in different states.

The time a work center takes to perform its tasks is determined by the settings in the Timing panel. If the work center does not work at this rate continuously (because of breakdowns or other in-efficiencies) specify this using the Efficiency button. (See page 131).

Work centers compete with each other for resources which are in short supply. Click the resource button to select which resources each work center needs. Each work center can be given a priority for obtaining its desired resources.

The routing - in and routing - out buttons control how the work center selects work items it gathers from feeding simulation objects and how it should feed complete work items onto others.

If the work center is relatively simple (for example it is not "Interruptible", or of "High Volume" or does not make use of any other special features) you can quickly find out how your model will perform with different numbers of this work center in your operation by using the quick replicate facility (see page 74).

To see a list of the actual work items in the work center at any moment in the simulation run click the contents button. This lets you also see the values of the work

items' labels. Actions let the work center change the values of labels of work items as they finish their work at the work center.

The high volume check box changes the way the work center operates into **SIMUL8**'s high volume mode for handling BPR and FMCG type applications. (See page 155).

Storage Bins

A storage bin is a place where work to be done can wait until appropriate resources or work centers are available.

A storage bin is one of the fundamental objects which make up the structure of your simulation model.

Storage bins (queues) can be displayed as a fixed icon (with or without a count of the work items within it and its name), or as an animated queue, or as a "tank". An animated queue shows every item in the queue (using the icon which has been chosen for displaying that type of work item). A tank shows the queue as a tank of liquid. The image on the screen fills up as work items build up in the queue.

For purposes of animation, storage bins are assumed to be "close to" the work centers they feed. This means the work items take no time to travel from a queue to a work center. However, work items may, take time to travel from a work center to a storage bin. (For information about "traveling time" see page 109).

Work Items can be allowed to "expire" while in a storage bin. For example if people enter a shop and are willing to queue for up to 5 minutes, set the SHELF LIFE in the storage bin dialog to 5 minutes. (See page 99).

When simulating some processes (e.g. an oven) you might want to use a storage bin to act as a simple work center but one which can contain many work items. However

you would want to set a minimum time that the work items must stay in the storage. Use the Min Wait Time box to set this minimum.

Some times you may not want your model to start its run completely empty of work items. In this case you may place work items into storage bins.

Click START-UP in the Storage Bins' dialog. You can specify which type of work items this storage bin is to be initialized with and how many of the work items should be placed here.

Sometimes the particular logic of your simulation model will mean that you do not want these storage bins to be part of your normal running model. In this case you can make them invisible (set the invisible check box in the storage graphics dialog). If you need to set up labels of the work items which are initially in your model when it starts to run click the ACTIONS button in the startup dialog. These label actions will be used to set the value of the labels as the work items are placed in the storage bin (while the model is being reset).

If the queue has limited capacity (for example it is a mechanical buffer), type the maximum number of items into the capacity box in the storage bin dialog (reached by simply clicking on the storage bin on the simulation window).

Normally work items join the back of a queue and do not leave until they reach the front.
Exceptions are:

> When items whose shelf life has expired are removed by an "expired only" work center.
>
> When items do not join the back of the queue because the queue is prioritized.

The storage area dialog box allows a prioritization option. If checked you are given the opportunity to select a label, the value of which is used to prioritize the work items at this storage bin. The higher the value of a work item's label, the higher its priority (the nearer the front of the queue it will be placed).

Zero is the lowest possible priority (negative values have the same priority as zero). Work items without the selected label are treated a zero priority.

This label (which can have any name) should not be confused with the "priority label" (See page 116)

Work Entry Points

A work entry point is a place where work to be done appears in your model for the first time.

You can have as many "work entry points" as you like. Each can feed work in using different statistical distributions (if required). Each can feed in Work Item Types of different types (if required).

To create a "work enters point", click the button and then click the mouse at the location you would like it to appear in the simulation window.

Connect it to other objects using routing arrows.

If you want to set the values of labels on your work items as they enter the model use actions at the work entry point.

Blocked Work Entry Points:
Note that work items will be "lost" (i.e. thrown away) if they cannot immediately proceed from the Work Enters Point to the next object on the screen. A warning will be given when this happens unless you have switched off these warnings using the

check box in the work entry point dialog. It is usually best to connect Work Entry Points to Storage Bins first, otherwise, if two work items arrive in quick succession, and the work center you have routed them to cannot accept them (if it is busy) then the work item will be discarded, and will not enter your model. Sometimes you *might* want this (if, for example, you want to simulate customers being lost because a phone system is busy).

Batching
This controls the number of items which arrive at one time. If an "arrival" occurs at time 10:30 and the number of items set to leave the "Work Enters System Point" is "Fixed" 20, then 20 items of the specified work item type will arrive at 10:30.

The number of items in a batch can be determined by a distribution.

Work Exit Points

A Work Exit Point is a place where work that is complete (or otherwise "finished") leaves your model.

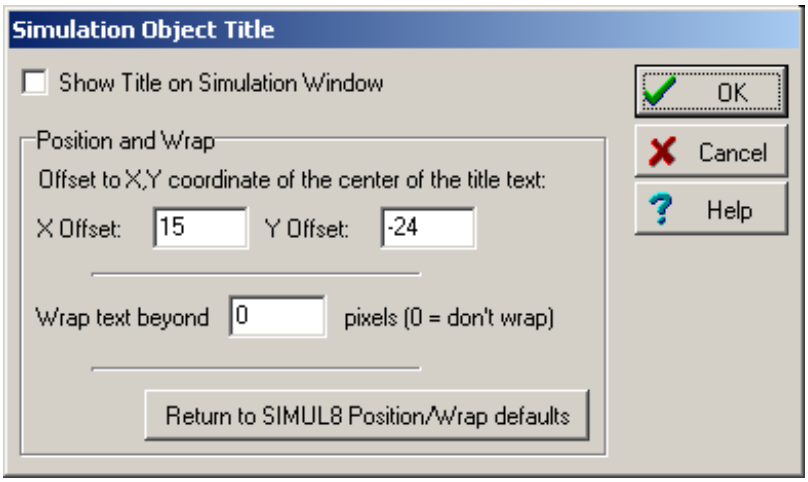
At the point in time when each work item leaves, data is recorded about how long it has spent in the model (from the time when it entered through a "Work Enters Point ".)

Displaying Object Titles

To show the title of an object select the object's Graphics option button and select Title.

The Titles of an Object can be diaplayed at any location around the object, and can be wrapped or offset.

Select any Object and then select its Graphics button and finally the Title button.



The title can be shown or hidden by ticking or unticking the Show Title check box.

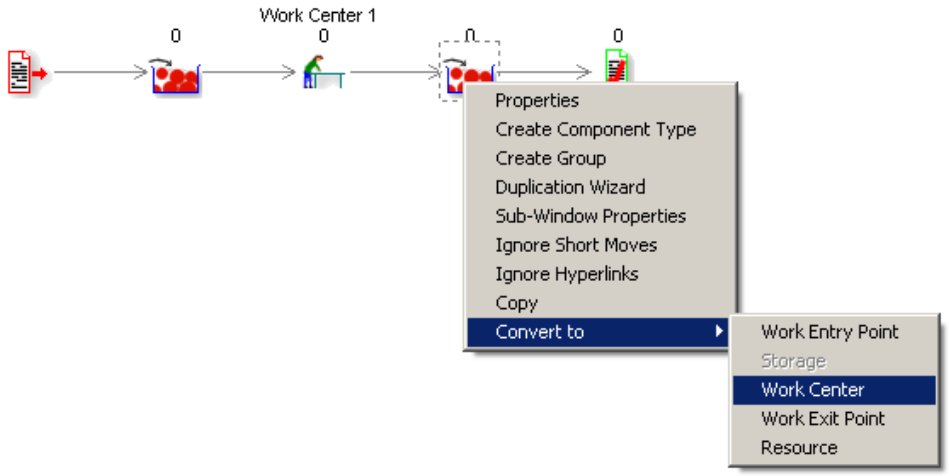
To move the title to the left or right change the X offset value. Setting the X offset value to a number less than 15 or a negative value will move the title to the left.

Changing the Y Offset value to a number greater then the default of -24 will lower the title on the screen.

To wrap longer titles change the Wrap Text Beyond value to a number greater than 0. We suggest you start at a value of 50.

Changing Object Typess

SIMUL8 Objects can be changed to another type after they have been created. This means that if you have created a Work Center and want to change this to a Storage Area then you can do this with 2 button clicks.



Select the single object or multiple objects to be converted then right click and select the Convert To option.

The selected SIMUL8 object or objects can now be converted to any other type.

Resources

"Resources" are items in the simulation model which are required at work centers in order for the work center to work on a work item.

Work centers cannot start work until both a work item is available and the specified resources are also available.

Resources are shared between all the work centers which used them. They are also know as "shared" or "floating" resources because they "float" between the work centers which require them.

Examples of "resources" are:

- Labor
- Special Fitments for machines
- Beds in a hospital ward

Resource Shift Patterns

Resources can be available for only part of the time a simulation is running if you make use of shift patterns to describe their availability. Use the resource shift availability dialog to describe how many of the resource are available during each shift.

Click on a shift name, then click on the availability number box and change this number to the amount of the resource you want to be available during this named shift.

To adjust the times when shifts are "on", add more shifts, or change their names use the Shift Patterns dialog from Clock / Shifts in the main menu. (See page 153).

Pooled Resources

Resources can be pooled so that (for example) Fitters can fit and Operators can operate but either Operators or Fitters can polish. A pooled resource is one that does not really exist but instead is a combination of other resources.

If task A can be performed by people A and task B can be performed by people B and task C can be performed by either A or B people then create a pooled resource called C and used the Pooled check box in the resource dialog and button to set that either A or B can be used whenever a work center is seeking resource type C.

To make use of a resource at a work center, in the work center dialog, click the resource button and ADD the resource to the list of resources required at that work center.

Multiple Resources at a Work Center

To specify that more than one of a particular resource is required for a task at a work center, click the PROPERTIES button in this resource selection dialog.

In the Min box specify the minimum number required (this defaults to 1 and there is no need to use this dialog if you simply need one resource of each type specified at the work center). If it is possible to reduce the time taken to perform the task by using additional resources then type the maximum number which can be used in the Max box. The time take to perform the task will be automatically adjusted as follows.

Actual time = Time with Min Number * (Min Number/Actual Number of Resources Obtained).

Actual Number of Resources Obtained is always as many of the resource type as **SIMUL8** finds free at the time the job starts (subject to the number in the Max box).
Time with Min Number is the time sampled from the work center's Timing box.

Converting Resources into Different Types

Resources can be released as a different "resource".

This makes it possible to indicate particular conditions to parts of the simulation model.

For example: If a doctor always completes two activities in sequence ("operate" and "clean up") then the operating theater work center could require a resource "doctor" but release this resource as "doctor A". A separate work center (perhaps called "cleansing") could require a resource "doctor A" and release a resource "doctor" - who is then ready to perform another operation.

When are resources released?

Resources are normally released by a work center as soon as the task at the work center is complete (NB see Resources Move with Work Item)

However, if a work center is blocked this means that the resource is freed up before the work center is available to do other work. In cases when resources are being used to control a sequence of tasks at one real life work center which is being simulated with a number of SIMUL8 work centers this might be undesirable. So this 'immediate release' facility can be switched off for particular work centers. Click the RESOURCE button in the work center dialog and unclick the check box for **'Release resources as soon as task complete'**

When are resources required?

Resources must be at a work center before the work center can start work and work items will not **normally** move to a work center before it can start work.

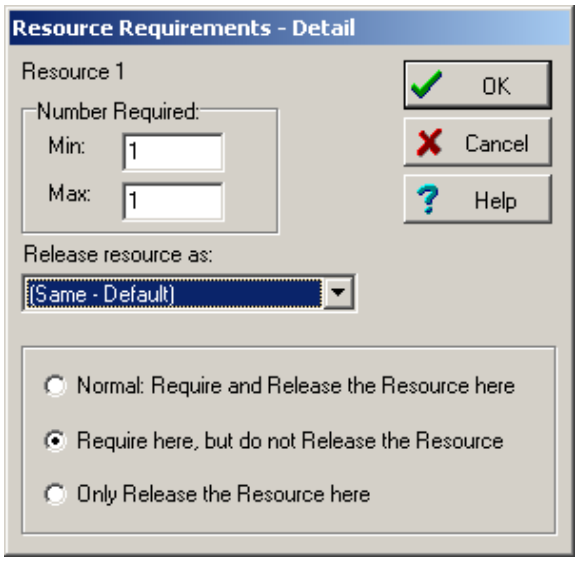
However, if "collect routing" is used to collect a number of work items into a work center for a task, then it is possible to de-select the default "require resources before collecting any work items" check box in the Resources dialog box. Reach this dialog box from the work center dialog box.

Resource Moves with Work Item

Normally, SIMUL8 resources are located at work centers only for the duration of a job.

They are released as soon as the job is complete. This means that they are free to move on to do other tasks and cannot transport the item from place to place.

The Detail option inside the Work Center Resources option button has 3 options that allow Resources to be controlled more precisely.



The Normal option is the default.

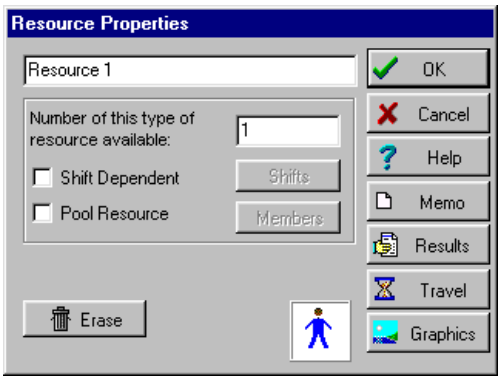
Require here, but do not Release the resource: this option attaches the Resource to a work item and forces the Resource to travel with the work item.

NB: as the resource is already attached to the work item any intermediate work centers that require the resource should not have their Resource Requirements set. As the Resource is attached to the Work Item the Resource will be required and present by default. If the Resource Requirement is set then 2 Resources will be required to allow the job to start.

Only Release the Resource here: this option allows the Resource to be released at the end of the job at the work center.

Together these options allow Resources to be used to transport items between work areas.

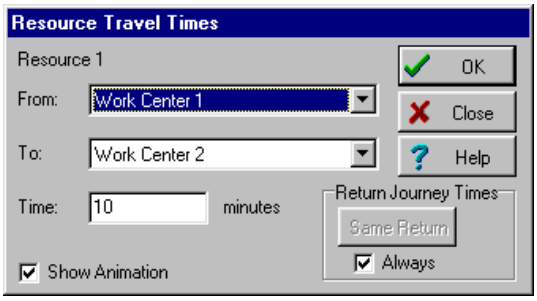
Mobile Resources



SIMUL8 Resources move between Work Centers. Their default is to travel instantly between Work Centers, and you can impose a Travel Time using the Travel option in the Resource Dialog.

Select the Travel button and then the source work center in the From list. Select the Work Center the Resource will travel to and then set the Travel Time in Time Units

If the Return Journey is to be different then Untick the Always option in the bottom right of the Resource Travel Times dialog.



There can be Travel Times set for as many combinations of journey as required, using the same dialog.

The Resource is animated by default, so it will be seen travelling between work centers

Invisible objects

Any object in your simulation model can be made invisible (so it is not seen when the model runs). You can do this so that you can remove information from the screen which is not important to see as the model runs. (See also: Simulation Sub-Windows, which let you place sections of your model in different windows, and only view those aspects which are relevant to the current decision).

For example you might include a work center to, say, control routing which does not really exist in the situation you are modeling (perhaps because the work items are intelligent and make their own choice about where to go!).

Object List Dialog Box

For fast access to an object just click it on the simulation window.

The Object List Dialog Box is a list of **some or all** the objects which form the structure of your simulation model. Access this directly from the main menu (OBJECTS and then any of the types or one of the search options) or also from many other dialog boxes which have options to link to other objects.

It is usually displayed so that you can select the particular object you need.

It can include the
- Work Centers
- Storage Bins (Queues)
- Resources (People and other items required to do work at Work Centers)
- Work Entry Points
- Work Exit Points
- Any other types of Components your have created

It can also include all the invisible objects too.

This list is not used to create new objects: To create a new object click the appropriate button on the tool bar and then click on the simulation window where you would like the object to appear.

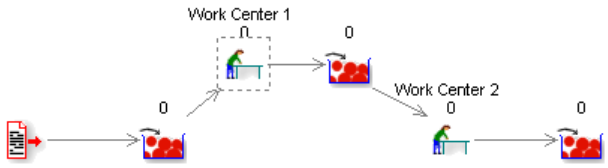
This list can also be used to delete objects. You can select a number of objects in the list at one time (click on them with SHIFT or CONTROL pressed on the keyboard - just like in File-Manager) and then delete them all by clicking the DELETE button.

You can get to see the details of an object more quickly by simply clicking on it on the simulation window.

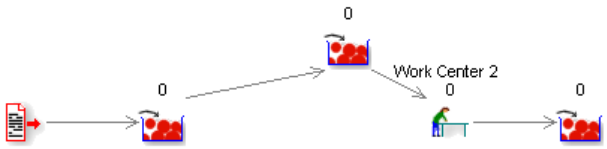
Deleting Objects

Objects can be deleted using the above "Objects List" but can also be deleted by clicking on them, and them clicking the ERASE button in the dialog box which appears, or by dragging a box around them and pressing the delete key on the keyboard.

When an Object is selected and deleted the Routing Arrows will be amended. In the example when Work Center 1 is deleted the Route Arrow will be redrawn between the 2 storage areas.
So this:



becomes:



Quick Replicate

This lets you quickly try alternative numbers of work centers which perform the same tasks.

Note that using this facility prevents access to many other work center facilities (e.g. break downs and utilization results information).

It is ONLY designed as a quick way to assess required capacity in an organization. In most cases you should simply copy work centers directly on the screen or use the Groups facility to represent multiple copies of the same work center (see page 157).

To use quick replicate click the REPLICATE button in the work center dialog. If this button is grayed out then it is not available (because you are already using one of the

facilities at this work center which cannot be validly modeled by using quick replicate). In this case use the duplication wizard (page 159).

Components

A more detailed description of Components is included later in the manual.

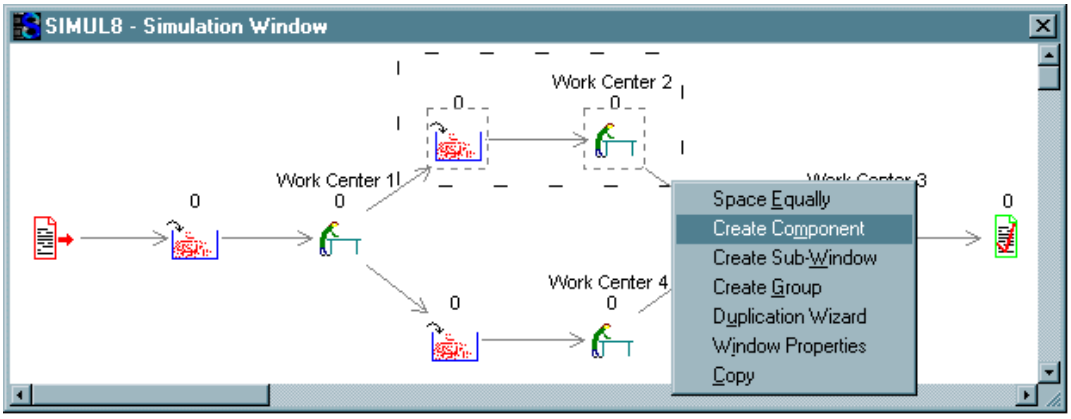
Components are new simulation objects built to any specification and added to **SIMUL8**'s standard objects.

Components consist of one or more existing objects (either the standards or other Components) that are tailored in some way then saved as a single new object for future use. They can be left open, so you or other users can re-tailor them, or they can be sealed up and password protected so their internal information is safe from adjustment.

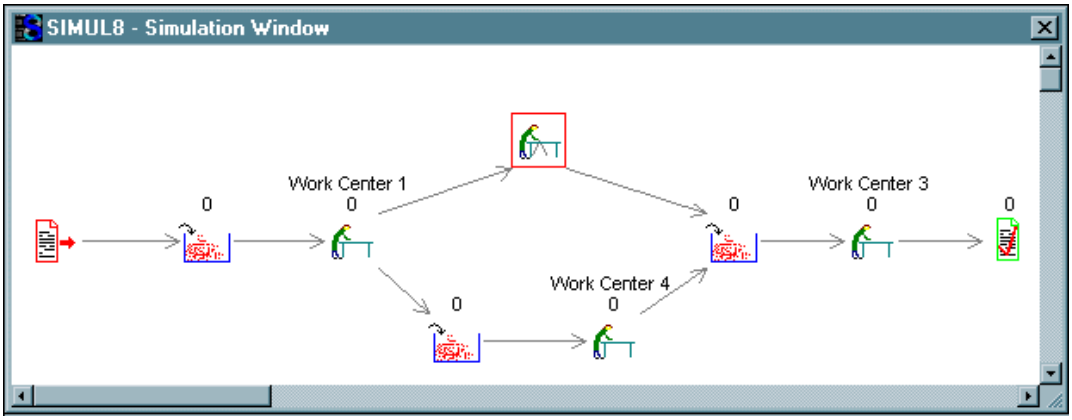
Creating a Component

Example: When creating simulations we want most work centers to have queues before them so we decided to create a Components type called QueueWork.

Define a collection of other objects that work the way required or load a simulation that contains the combination of objects you require:

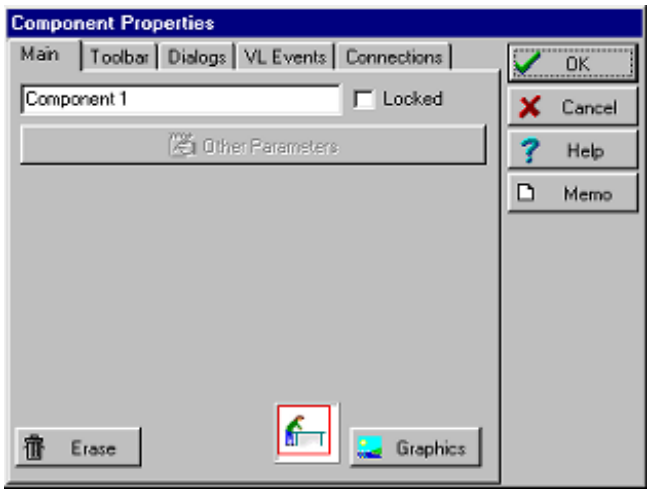


Select the combination of simulation objects and click RIGHT and choose CREATE COMPONENT.



The new object has been defined. It can now be copied, moved, linked to other objects etc within the current simulation.

To change the name of the Component from "Component 1" to "QueueWork" click on the object to see its properties box.



To be able to reuse the object in other simulations and to add it to the tool bar for easy addition to the current simulation, click on the Component to open the properties box and click the Toolbar button. Then click SAVE AS REUSABLE COMPONENT. This saves the Component in **SIMUL8**'s Object Repository directory. Any objects in this directory automatically appear on **SIMUL8**'s toolbar when **SIMUL8** starts (or when a new component is saved there). To see the Component on the toolbar you need to select the BUILD TOOLS 2 toolbar (click RIGHT on the tool bar area).

To customize the dialog that appears when the Component is clicked see Custom Dialogs.

Hierarchical Modeling

Sub-Simulation Windows

The simulation window does not itself have to show all the detail in your model.

With a complex model you may want to summaries your model at different levels. Achieve this by creating sub-windows and sub-windows within sub-windows.....to any level of depth you require.

When a sub-window is closed its contents are represented by a single icon on its parent window.

Create a sub-window by dragging a box around the objects you would like in the sub-window and clicking the RIGHT mouse button.

Choose: CREATE SUB-WINDOW.

All the objects inside the box are moved to the new sub-window and are replaced on the parent window by a single icon.

If you close the sub-window the only representation of the objects in the sub-window is the single icon on its parent:

You can open a sub-window by double clicking on its icon.

The default icon used to display a simulation window can be changed (click on the window's top left icon and choose WINDOW PROPERTIES in the menu.) Any image can be used (or you can create a new image or load an icon or bitmap from disk). You can also use this dialog to change the sub window's title.

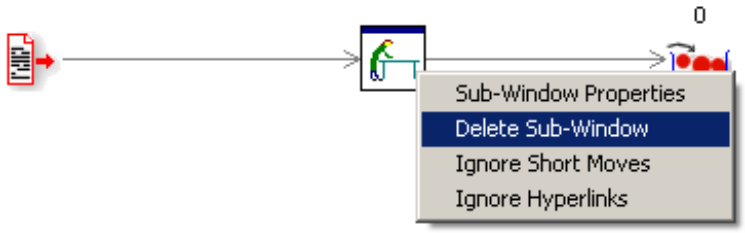
When the mouse is on top of an icon for a sub-window it changes to be an arrow with a window, to make it easy to distinguish icons for windows from icons for simulation objects.

You can move a sub-window so that it has a different parent window by simply dragging its icon on top of a different currently open simulation window.

Removing Sub-Simulation Windows

These windows can be removed by clicking the SIMUL8 logo in the top left corner of the sub-window (just once) to bring up the system menu and selecting the Delete This Sub-Window menu item.

Alternatively, when the Sub-Window is closed right click and select Delete Sub-Window.



This method deletes the Window and its contents.

Deleting a sub window places all the objects that are in the window onto the window's parent window (in the same location as they appear on the screen before the sub-window was deleted).

You cannot delete a sub-window if it currently has one or more sub-windows itself. Delete these first. This is so that the objects which are moved up a level know where to appear on the screen.

You cannot delete a sub-window unless its parent is currently open. Open its parent first. This is because the icons in the lower level would not know where to appear in the parent level.

Closing a sub-window

If you double-click a sub-simulation window's close box (or top left icon), or choose the CLOSE menu item, or minimize a sub-simulation window the window will disappear and you will only see the icon which represents all the objects on its parent window.

To actually delete a sub-window (and return all its objects to the parent window) see: Removing a sub-simulation window.

Important Control Features

This section details important features in **SIMUL8** which aid your building of models. We assume here that you are familiar with using WINDOWS and with the features which are common to most windows packages. If not we strongly suggested you run the excellent Windows tutorial which comes with windows. (From Program Manager, or from **SIMUL8**, click the mouse on the HELP menu item and then on the WINDOWS TUTORIAL menu item.)

Select, Move and Copy Objects on Screen

To **see** the detail of a simulation object on the screen, just click on it.

If you want to **move** an object, drag it with the mouse.

To **copy** an object, drag the object to where you would like its copy to appear with the CONTROL key pressed on the keyboard (this is the standard WINDOWS method of indicating you want to COPY something).

You can copy or move many objects at the same time if you select them all first.

Select a number of objects by dragging a box around them.

You can then drag the box to move the objects in it (or copy them by also holding down CONTROL).

Select additional objects by either clicking them with the CONTROL key pressed (just like you would in WINDOWS file manager) or by dragging more boxes around

objects with CONTROL pressed. (As long as the start of the drag is outside an existing selection, you can go on making as many selections as you like.

Then just one drag (from within a selection) will move or copy as many objects as you like.

Move

Moving an object changes its place on the simulation window. It remains connected to the same objects as before.

Copy

Copying an object produces a new object which is connected to the same objects as the object from which it was copied. The new object also has the same parameters (e.g. breakdowns, maximum size etc.) as the object from which it was copied.

When a number of objects are copied, the new objects are connected to each other, where appropriate, to maintain the same structure as existed in the original group of objects that were copied.

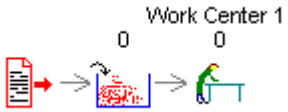
New objects are given the same names as the originals except that a number is added to the end of the name to make the name unique. (If the object name already has a number at the end, then this number is changed).

Normally, when groups of objects are copied, the resulting objects are connected in parallel with the original object. **SIMUL8** does however detect when it is appropriate to connect objects in series.

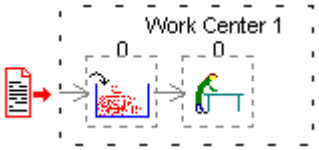
For example:

If you want to create a process simulation which looks like this:

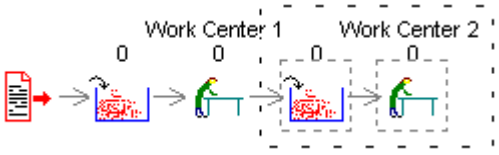
Then the quickest way is to create:



Then copy the last two objects by selecting them:



and dragging them with CTRL pressed so the first of the new set of objects (the new storage bin) is close to the last of the old set (Work Center 1):



SIMUL8 automatically creates the new routing arrows so the new set of objects is in series with the old one when the old set has only one input route and no output routes AND you place the new first objects close to the old last object.

Now keep copying the last pair as often as you need.

(To make a large number of copies of simulation objects it may be easier to use the Duplication Wizard - see page 159).

Aligning Objects on the display

If you have a line of objects on the screen which are almost aligned either vertically or horizontally you can tidy them up by selecting them and then clicking the RIGHT mouse button. This provides access to a the Align and Space Equally functions

Shuffle

You can "shuffle" objects by selecting and object or objects and then pressing the arrow keys on your keyboard to make fine "pixel -by-pixel" adjustments.

UNDO

Undo **ONLY** works if UNDO is enabled. (By default UNDO is enabled).

Click the Undo button ( ) to remove the changes which have most recently been made to your model. **SIMUL8** stores up to 20 previous sets of changes. To select any of these (rather than just the most recent) use EDIT / Undo..... from the main menu. The model reverts back to the point mentioned in the Undo menu command.

Redo

Redo lets you put back the changes which were removed by the most recent Undo operation. Access Redo from the Edit menu.

Enable/Disable UNDO

Enable or disable undo using the File/Preferences menu.

It is a good idea to keep Undo enabled in case you should make a mistake which is time-consuming to recover from. However, on slow computers, or with large models, Undo can delay your work because of the large amount of information which the undo facility needs to handle.

If you find your model is slow at opening dialog boxes to edit objects on the screen, try disabling undo.

The default setting for Undo cause it to always reset the simulation clock to the start of the simulation run after you "undo". File/Preferences can also switch this off. However, to operate in this mode **SIMUL8** has to store all "results" information when it saves information about how to undo. With a large model which has run for a long time this can use considerable amounts of disk space.

Find

OBJECTS / FIND in the main menu can be used to search for any text in the titles of any simulation objects. If an object is found its name is displayed in the list which can then be used to access the object's properties.

You can also access the FIND facility by pressing CTRL-F on the keyboard.

Preferences

The FILE / PREFERENCES menu item lets you select a number of options that customize the way SIMUL8 works with your model.

Details of each option can be obtained by hovering the mouse over the option. The purpose of each of the Preference tabbed pages is:

Undo

The Undo option is intended to manage the amount of memory used by PCs when creating Undo steps. Turn this option off only if your PC is short of disk space,

Distance:
Change the default units of measurement to either feet or meters. Also enables a global setting to disable timing on all routing arrows.

Files:
Sets global settings for default Save and Open directories, and allows memory saving options to be enabled.

Results:
SIMUL8 results are updated every 5 time units by default. This can lead to large amounts of memory being used for results, especially in models with long Results Collection Periods. Increase the period to save memory.

Timing:
Purely a visual setting, this enables the clock to appear to move at a steady rate, or to appear to jump to the time scheduled for the next event.

Automation:
SIMUL8 automatically alters Storage Bin names and creates routing arrows by default. This is not always desirable, and these options can be turned off.

Display:
Contains a variety of options to personalize the Display of SIMUL8. This option also allows the display of Utilization above work centers.

Compatibility:

Allows certain features or ways of operation in SIMUL8 that have altered through various versions to be re-enabled. This allows seamless backward compatibility, and permanent enabling of the Conveyor features.

The Simulation Time

SIMUL8, like all simulation packages, contains a clock against which the model runs. (Everything in the model is adjusted to match with what would happen in the real situation at the time which is currently shown on the clock). The clock runs much faster than it does in real life. This enables you to watch what happens in the situation you are modeling in fast-time - so you can gain insights as to how to improve it.

Clock

The format of the clock can be changed using the CLOCK / CLOCK FORMAT menu or by "double-clicking" the clock window.

The clock can be digital or analog and can show information about the day and week too.

Results Collection Period

The results collection time is how long the model should be run before automatically stopping while collecting results. The model will not start to collect results until the warm-up-time is finished.

Set the results collection period from CLOCK / RESULTS COLLECTION in the main menu.

For a detailed discussion of this aspect of simulation modeling see the section "Simulation - The Technique - A Guide"

Warm Up Period

The warm up time is the time that the model will run before starting to collect results. This allows the queues (and other aspects in the model) to get into conditions which are typical of normal running conditions in the system you are modeling.

Sometimes you do not need a warm up time. An example of such a situation would be when you are modeling a shop which starts and ends the day empty. A warm up time would be required when modeling a week in a factory, when the factory starts on Monday morning in the exact same state as it finished on Friday evening.

Set the warm up period from CLOCK / WARM UP in the main menu.

For a detailed discussion of this aspect of simulation modeling see the section "Simulation - The Technique - A Guide"

High Speed Clock

Changing and updating the clock on the display can take a significant proportion of run time. While the most aesthetically pleasing view of the clock is achieved by keeping the clock exactly in line with events on the screen, this is slower than using the "automatic" clock refresh mode.

In Automatic mode the clock is updated only once every 1/10th of a second.

Use Clock/Format and then the MORE button to change the clock update mode.

An accelerated version of the high speed clock is automatically used when the simulation window graphics are not being updated (when the speed control is set to full speed).

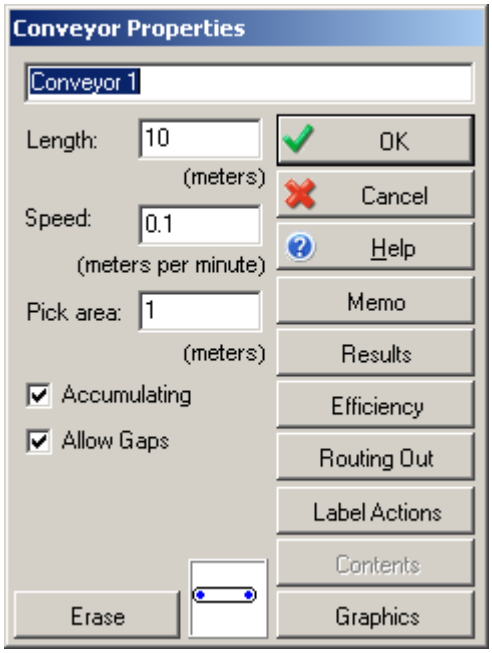
Conveyors

Conveyors are not displayed when SIMUL8 is first run, and can be enabled by using the Tools menu, Preferences option and then selecting the Compatibility tab (scroll to the right to find this).

The Conveyor icon will appear on a new Toolbar and can be dragged and dropped to the Simulation Window.

Conveyors are a means of transporting work items around the system you are simulating. They can be used in ways similar to Work Centers, as they take time, but they also have similarities to Storage Bins, in that they store multiple items.

Conveyors can be displayed as standard icons, file based icons/bitmaps or as animations showing the location of each work item on the conveyor. They are animated in the same way as storage bins except that in moving the animated display with the mouse the two handles on the screen represent the front (destination) and end (source) of the conveyor, rather than the first and second items in the queue.



The length of the conveyor and the size of the work item determine the number of work items that can be on a conveyor at any one time. The size or length of a work item can be controlled by using the reserved Label name Length.

The speed of a conveyor, combined with its length affects how long it takes a work item to travel from the start to the end of a conveyor (assuming no other work items block its progress).

Conveyors can be either "Accumulating" or "Fixed".

When Ticked the Allow Gaps check box allows the conveyor to continue to run when there are no items waiting to be loaded.

When Unticked the Allow Gaps check box commands the conveyor to wait whenever a gap will appear on the conveyor if an item is not ready to be immediately loaded.

A conveyor actively pushes work which reaches its end onto the next available simulation object. Use the Routing Out option in the conveyor dialog to affect how the conveyor decides where to send work items.

Routing

Routing lets you control the path taken by each individual work item through the simulation model.

You have an opportunity to control routing as work items enter and leave objects on the screen.

Click the Routing In or Routing Out buttons in the work center dialog box.

Routing can be controlled at work centers and conveyors but can also be controlled at other objects by using "invisible" work centers.

Drawing the Routing

Draw the route your work items take by using the main simulation window. (Please note that in the case of very simple models **SIMUL8** will help you by drawing the route for you. However, as soon as it realizes its guesses about the route are not helping you, it will stop doing this).

There are two ways to add and delete routing arrows. Which way you use depends on your own preferences for use of the computer and the mouse.

The first involves using the SHIFT key on the keyboard:

> Press the SHIFT key on the keyboard and drag with the mouse from the first (source) work center (or other simulation object) to the second

(destination) work center. Let go of the left mouse button when the mouse arrow is over the destination work center.

The second (and many people find this easier) is to click the Route Drawing Mode button ( ).

Click the Route Drawing Mode button so it is down, then click on the first (source) work center (or other simulation object) and then on the second (destination) work center to describe the route. You can click on a series of simulation objects to create a series of routing arrows, then click the Route Drawing Mode button again to release **SIMUL8** from this mode.

You can also connect / disconnect routings inside the Routing-In and Routing-Out dialogs for Work Centers.

Deleting a route arrow

To remove a route simply redraw it (using either of the above methods).

Either:

Drag (with SHIFT on the keyboard pressed) between the *source* and the *destination* work centers.

Or:

Click the Route Drawing Mode button so it is down, then click on the first (source) work center and then on the second (destination) work center.

Alternatively click on the arrow to select it. When the handles are displayed press the Delete button.

Switch Route Lines on/off

The route lines can be switched on and off at any time when the model is not running by clicking the button.

Bending Route lines

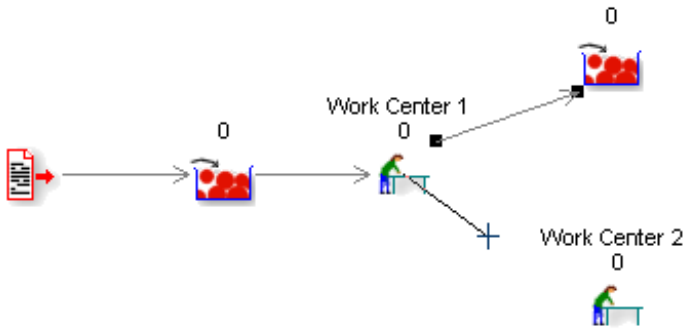
Routing Arrows can easily be bent and shaped.

Select a Routing Arrow by clicking on it, then drag and drop the center of the arrow to the desired location.

Changing Routings

Routing Arrows can be moved to change either their source or destination.

Select a Routing Arrow by clicking on it. Handles will appear at either end. Select either handle and drag it to the desired location.



In this example the arrow from Work Center 1 is selected - the handles are shown - and is being moved to Work Center 2. This is accomplished by selecting the handle at the Storage Bin and dragging it to Work Center 2.

Either the source or destination of a Routing Arrow can be changed in this way.

Routing In to a Work Center

Click the Routing In button in the Work Center dialog box.

This lets you control where a work center gets the work items on which it works.

The following routing methods are available when selecting work items:

Priority in determining the Work Item to select for a Work Center

Selects a work item from the first place in the list of objects which feed this work center. If no work item is available from that place, then the 2nd object in the list is tried, etc. etc.

Collect work items

This method of "routing" work items into a work center lets you collect a number of work items from a number of places.

For example you might want 12 bottles of whisky and 1 box.

When they have all been collected the work center will start work. Only one work item will be worked on and by default this is the first work item in the list of work items.

By default a work center does not start collecting the items it needs until it has all the resources it needs.

Collect Options

When Collect is selected and the More option button pressed, the Collect Options are available and displayed.

Match

The Match option will search multiple queues for identical Label values, particularly useful, for example, for matching orders to order paperwork.

Assemble

Assemble, when ticked, assembles 2 or more items into 1 product item. When unticked the assembly process does not take place and the same number items will be produced as collected.

Assembly Time In System

The Work Exit Point result Time in System can be affected by the Collect option. Select the option that will deliver the work item with the appropriate Time in System.

Passive

The Passive rule disables the Pull into the Work Center. This means that the work center will no longer pull from a storage bin, but will need to be fed work items by another Work Center or Work Entry Point.

Passive is normally used to prevent Routing Conflicts where Work Centers are connected to each other.

The remaining Routing In Options are accessed through the More option button.

Expired Only

Use this Routing-In discipline to tell the work center to ONLY accept work items which have been in a storage bin for more than the "shelf life" set for that storage bin.

Shelf Life

Shelf Life is a parameter of a Storage Bin, and is used in conjunction with the Expired Only option in a Work Center. It controls how long a work item can usefully stay in a queue.

Setting the shelf life by itself is not sufficient to change the way your model works - you must also say what is to happen to the work item when its time expires.

Set up a route arrow to a work center which has its ROUTING IN set to "EXPIRED ONLY". This work center will then not normally take work items from the queue (storage bin). It will only accept work items whose time has expired.

Time expired work items will be sent to any other destination from the storage bin if they reach the front of the queue without being removed by a work center which is set to search for expired items (this might happen if your "expired items" route is busy).

If you want to avoid this then your "expired items" work center should simply pass the work items onto wherever they need to go (with a zero processing time) to avoid the possibility of blocking expired items.

You can make shelf life a variable which is different for each work item by using a work item's label to contain the amount of time before the work item should expire. Tell a storage bin to use a particular label for this by double-clicking the box in which you would type a fixed shelf life.

Oldest

This option instructs the Work Center to scan the items at the head of the feeding queues, and to select the item that has been in the simulation longest. This option uses the time that the items has been in the simulation.

Youngest

This option instructs the Work Center to scan the items at the head of the feeding queues, and to select the item that has been in the simulation for the shortest time. This option uses the time that the items has been in the simulation

Use Queue Time

The Oldest and Youngest options use the time the work item has been in the system when identifying the items to select. If the Use Queue Time option is ticked then the item that has been in the queue for the longest, in the case of Oldest, or shortest, in the case of Youngest, is selected.

Longest

This option instructs the Work Center to pull items from the queue that contains most work items

Circulate

Work Items are taken in order from the locations listed. If an input to the work center does not contain a suitable item it is ignored and the search continues at the next location in the list.

When ticked, the Ignore Starved option allows SIMUL8 to simply skip any route that has no work items ready for puling into the work center. If the option is not ticked then the work center will wait until a work item is ready to be pulled.

Locked

Normally this option is only used through Visual Logic. Manually it locks the Work Center to only accepting inputs from the source highlighted when Ok is clicked. If no route is highlighted, and Locked is selected then all the routes are Locked Out, preventing the Work Center form accepting any inputs.

Interruptible Work Centers

Normally work centers always finish the task they are working on before they consider starting work on a second work item. However, in some environments low priority tasks are performed which can be interrupted by other more important jobs.

Set a work center to be "interruptible" by checking the check box in the Routing In dialog (it is items of high priority coming into the work center which may interrupt existing work). Each interruptible work center must have a storage bin associated with it which will automatically receive interrupted work items. (Such items do not leave the work center using the normal "routing out" mechanism). You will be asked for the storage bin to use when you check the "interruptible" check box.

Only work items which have a value in their "priority label" which is greater than the value in the work item being processed will actually interrupt the work. For a work center to be interruptible it must be fed by an object which actively pushes out work (like a work center). Storage Bins do not actively feed work onward, they simply wait

for it to be pulled. If you need to have work items in a storage bin interrupt work at a work center, simply feed the work items to an intermediate work center which takes zero time to process and feeds directly onto the interruptible work center.

Label batching

Label batching lets you batch together work items for a task to be performed at a work center. You select a label which the work items will all know about (for example "Volume").

As work arrives at the work center **SIMUL8** adds up the values in these labels until they reach at least the minimum batch size, but not more than the maximum batch size.

If the work center can take a maximum of 200 gallons of "volume" and you are prepared to work with any batch of at least 50 gallons then you would set the batch sizing parameters to 50 and 200 and "use" label "Volume"

In the routing in dialog click the USE LABEL BATCHING check box and select a label to be used.

Batching by type

This method of routing in to a work center tells the work center to only accept work items which have a certain value in one of their labels. Select a label which will contain a value that in your model identifies the type of work (e.g. product code, illness type).

When the work center cannot find any more of this type of work (in any of the objects which feed it) then it will automatically look for a new type. When searching for a

work item of the same type the work center will look anywhere in the queues that feed it (not just at the head of the queue).

Negative and zero values are not allowed (they will cause any product to be accepted next).

Routing Out of a Work Center

Use the routing-out dialog to tell SIMUL8 where work items should go next after being at a work center.

If one work center is connected to the next with one simple connection (arrow) then the routing dialog has no options.

If there is a choice of two or more locations to go to then the routing dialog box can be used to change the routing rules.

Available routing rules are:

- Circulate (the default)
- Uniform
- Percent
- Priority
- Label
- Shortest Queue
- Jobs Matrix
- Passive

Changing the work item during a task at a work center

To have a work item of a particular type enter a work center and a different one leave, click the Routing Out dialog box in the work center and change the work item type. By default the work item leaving a work center is the same as the one which enters.

If two work item types have labels with the same name, the values in the labels are copied across from the work item which entered the work center to the work item which leaves the work center. Statistics on the amount of time a work item has been in the system are also transferred. This means that "widget unfinished" can change into "widget finished" and retain all data if required.

Data is NOT transferred if "collect" Routing In is used.

List of Destinations

These are normally set by drawing the routing on the simulation window. However, you can directly add or remove simulation objects from this list using the ADD and REMOVE buttons in the routing out dialog.

Depending on the routing out discipline, the sequence of the objects in the routing out list can be of some significance. For example, "priority routing" attempt to send work items to the first object in the list. To change the sequence, click on one of the name of an object in the list and use the UP and DOWN buttons.

To change the percentage of work items which are routed to each destination (when using the percentage discipline) click on the destination you wish to change and enter the new percentage in the percentage box.

Preference Routing

In addition it is possible to specify what should happen if the chosen route is blocked. "Preference Only" means that if the desired route is blocked then the same rule will be used again to find another route. Switching "Preference Only" off means that once a route has been chosen (using the rule), then for this particular work item leaving the work center, it **must** go down the chosen route and it will wait until that route becomes available.

"Preference Routing " does not apply some types of routing rule.

Circulate Routing Rule

The first work item will go to the first destination in the list, the second work item to the second,...., the Nth work item to the Nth destination on the list. The Nth+1 work item with go to the first destination etc. etc. (Thus the decision about where to go next "circulates" through the list).

Priority Routing (First Destination = First Choice)

The priority routing rule sends all work items to the first destination in the list, unless this is blocked, when the 2nd is tried...and so on.

Uniform Routing Rule

The destination is decided randomly with each destination having an equal chance of being chosen.

Percent Routing Rule

The destination work center is decided randomly (like "uniform ") except that the exact percentage going to each destination can be specified.

To change the percentage of work items which are routed to each destination click on the destination you wish to change.

Percentage Automatically = 100

If the percentages do not add to 100 they will be pro-rata adjusted when you click OK to exit from the dialog box.

Alternatively you can click the "=100" button to adjust immediately.

Label

Label based routing will send work items along a route that corresponds to the value of a Label contained on the work item. For example if a work center has 2 possible routes out a work item with Label value 1 will be allocated to the first listed destination, and to the second destination if it has Label value 2.

In this case Label values 0 or 3 will be sent along the closest possible route to the value contained by the work item - in this case routes 1 and 2 respectively.

Shortest Queue

This routing method sends Work Items to the queue which is shortest. If one or more of the places to which work items can be sent is a Work Center then work items will go to the work center if it can currently take more work. i.e. - A work center which can take work immediately counts the same as a queue with nothing in it.

Jobs Matrix

The jobs matrix is a table of information that controls complex routings and timings. A detailed description of the Job Matrix is provided in the section on Alternative Routing Methodologies later in this section.

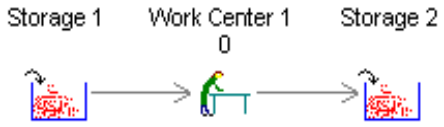
Passive

Passive routing means that the object does not attempt to pull (for passive routing in) or push (for passive routing out).

Work centers normally attempt to pull work in and push work out when it is complete. Either of these can be switched off in the routing in and routing out dialogs.

Additional Routing and Timing Control

Sometimes it is useful for a work center to control the flow of work between two storage bins without actually holding the work for any time in the work center.



If this is achieved by setting the work center to take zero time then two things can happen:

1) If Storage 2 has no capacity limit then all the work in Storage 1 will pass to Storage 2 immediately it enters Storage 1.

2) If Storage 2 has a capacity limit then 1 item of work will leave Storage 1 before Storage 2 can accept it, and will wait in the work center.

Two new options avoid the above situations: "Wait till exit clear" and "Zero timing"

Wait till exit clear

In a Work Center Routing In dialog choose the Options tab. Check "Wait till exit clear" if the work center should not attempt to draw work in until its exit is able to accept work. Note this test is only performed at the time the work is loaded and it cannot be used with routing out disciplines where the exit route cannot be determined at the time the work item is loaded.

Zero timing

In a Work Center click the Timing button. Choose "Zero, use time for interval to next job". This causes the work center to hold the work for no time and to immediately route it out to its destination. The work center will then wait empty until a time has passed before attempting to load the next work item. The time waited is determined by the work center's normal timing distribution information.

Traveling Time

Work Items travel between objects on the screen automatically. Their travel is animated so that you can see the movement of work around the system you are modeling, however the travel does not necessarily use up "simulation time".

When a Routing Arrow is created it displays the Distance and Travel Time on the Routing Arrow for 2 seconds.

Some objects are always assumed to be immediately adjacent to the objects they feed. In this case you can still see work items move between the objects, however, simulation time is not used during this traveling (the clock freezes while the work item moves between the two objects).

Travel between objects takes up simulation time when items move from:

WORK CENTER	to	STORAGE BIN
WORK CENTER	to	WORK EXIT POINT

As you adjust the speed bar you will see less animation, this enables your computer to make the model run faster. However, the logic of your model is unchanged. Adjusting the speed of your model with the speed control has no effect on the results of the model.

You can tell **SIMUL8** to automatically set up travel times based on their distance apart on the screen.

Use the GRAPHICS / DISTANCE menu to change the parameters used to define the time it takes work items to travel between some objects in the model.

Objects which feed work centers are assumed to be close to the work center and so no time delay is introduced between the work item leaving any object and reaching a work center. However, work centers may feed storage bins which are some distance away and it may take some time for work items to travel to these locations.

To change the distance between a work center and the object it feeds click TRAVEL in the ROUTING OUT dialog (if the button is gray, then click on the name of the relevant simulation object in the routing out dialog).

A travel link is a route (gray arrow) along which it takes time for work items to travel.

If you set the travel time to zero then the two objects are directly linked (without any traveling time required between the objects) - this is the same as setting up the routing links with "automatically set up traveling times" NOT checked.

You can switch off the automatic set-up of travel times (so all links take zero time) using the File / Preferences / Distance dialog. You can also use this to change all existing non-zero travel times to zero. If you want to recalculate all existing non-zero travel times use the File / Preferences / Distance dialog.

Labels

Labels can be attached to any "work item" going through the simulation. For example you might attach a label "Illness" to work item type "Patients" and set this label to a code number as they enter your simulation of a hospital. Each code number would represent a type of illness and could be used to route the patients though the different "work centers" in the simulation.

Labels have Names (e.g. Illness) and content (e.g. Twisted Ankle). All Patients have a label named "Illness" but only some of these contain the text "Twisted Ankle".

Labels can contain either text or numbers.

Tell work centers to change the values of labels using the LABEL ACTION button in the work center dialog.

Labels can be used to tell work centers which distributions to use for sampling work times. Labels can also be used to route work items, to collect data and for a number of other purposes.

Adding labels to Work Items

To enable a work item to be controlled by a label's content or to be able to collect data in a label, you need to first add the label to the work item.

Use the main menu OBJECTS / WORK ITEMS to select the work item type. Click the PROPERTIES button. Now click the ADD button to be able to select a label to add to this work item type.

If you forget to add a label to a work item type, **SIMUL8** will identify this (usually once the simulation is running), and will give you an opportunity to have the mistake corrected automatically.

Labels Containing Numbers

Values in labels can be fixed numbers, come from distributions or come from the results of calculations.

Use numbers in labels to, for example, affect the route work items take through your model.

Labels Containing Text

Text in labels can be used, for example, to select which distribution to use at work centers and how the work items are displayed.

Labels List

Use the labels list dialog box to select the label you want to use.

Click the NEW button to create a new label which you can then use.

To select a label to use, click the name of the label, then click OK.

If you want to find out more about a particular label, click the name of the label, then click the properties button.

Labels can only be deleted if they are not in use by any work item or work center.

Label Actions

Label Actions allow work centers to change the values in the labels of work items.

Use the Label Action dialog box to tell a work center how to change a work item's labels as it comes through the work center.

List of Action Labels

Labels in this list are controlled by this work center. If a work item is processed by this work center and it has one or more of these labels then the label will be changed when the work center finishes the processing time for the work item.

Other labels attached to a work item are ignored.

If a work item type does not have one of these labels, then that "action" has no affect on the work item.

The highlighted label is the one whose details appear in the "action" box to the right of the dialog box.

Use the ADD and REMOVE buttons to select which labels are affected by this work center.

Add to the list of Action Labels

Use the ADD button to add to the list of labels affected by this work center. Clicking the add button brings up a list of all labels which exist in the model. At this stage you can add to this list.

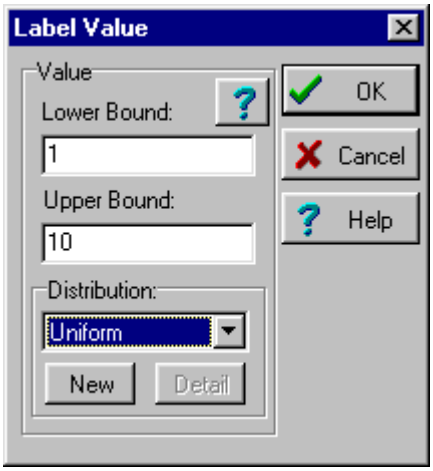
Remember that a work center cannot change a label if a work item does not have that label!

Remove Action

This button removes the highlighted label from the list of labels which can be changed by the work center.

Label Value

The label's value will be set to the value supplied from this dialog box:



In some cases you will simply want to set the label to a fixed value, in which case set "Distribution" to "Fixed". In other cases you may want the value to be set to a value which is sampled from a distribution. The distribution you sample from can be any which have been created anywhere in your model.

Label Text - Setting

Use this dialog box to change the text which is in a label as it passes through a work center's "actions".

The text you enter in the field in this dialog box will be placed in the named label.

This text can later be tested in other work centers and can be used to determine which distribution should be used to sample times for the work item.

Labels control Work Item Images

To use labels to change the image used to display a work item as it completes work at a work center ensure one of the work items labels is set in one of the ways described below.

The value of the label DOES NOT have to be changed by the work center's ACTIONS but the label does need to be listed in the ACTIONS (the particular label can be set to NO CHANGE if desired).

Text labels:

> If a work item has a text label with the name IMAGE and that label is listed in a work center's ACTIONS then the image for the work item will be changed to the image named in the label. (**SIMUL8** looks for an image whose name matches the text contained in the label of the work item).

Number labels:

> If a work item has a number label with a name beginning with IMAGE: and that label is listed in a work center's ACTIONS then **SIMUL8** will take the rest of the label's name and add to it the value in the label and then look for an image with that name.

For example a label called IMAGE:Product containing the number 4 will cause the work center to change the work items image to Product4 (if that image exists).

In all cases, the IMAGE button in the work center GRAPHICS dialog has priority over any changes based on labels.

Reserved Label Names: Special Labels

Some label names have a special meaning in **SIMUL8**. We have already seen how labels can contain the names of distributions to be used to sample processing time and how labels whose names beginning with "IMAGE" can be used to change the look of a work item.

Priority label

Labels are used to control priorities in a number of ways. In many cases any name of label can be used because the particular facility will ask the name of the label to use. The "Priority" label (which must be called "PRIORITY") is used by **SIMUL8** automatically to determine whether a work item can interrupt another work item.

Due label

The Due label (always called "DUE") is set, if it exists, to the amount of time which was remaining when a work item was interrupted at a work center.

Quantity Label

The Quantity Label determines the size of batches (one batch = one work item) at High Volume work centers.

Length Label

The Length Label sets the length of a work item. This is important if Conveyors are used in a simulation, as work item length is the determinant of the conveyor's capacity.

Routing using Labels

To route a work item depending on label value: Select LABEL in the routing dialog and click the PROPERTIES button to select which label to use. The work items to be routed must have this label attached to them. If a label is missing from a work item type which goes through the work center, then the default routine rules (circulate) will be used.

The value of the label should be between 1 and N, where N is the number of alternative routing destinations.

If the value is > N the Nth destination will be used. Similarly the 1st is used if the label is zero or less.

For an example of routing using labels see the example model: ATACTION.S8

Routing: Alternative Routing Methods.

SIMUL8's routing methods are normally controlled by Routing In and Routing Out of Work Centers or other objects such as conveyors and work entry points. These methods generally refer to Routing Arrows and push or pull items along the arrows connected to the objects.

Alternative methods that do not rely upon the existence of Routing Arrows exist, however and are:

Cycle Matrix: Use the Cycle Matrix when the emphasis is not on the flow of work, but rather the sequence of steps taken at a work center. For example if you think about work in terms of a work center doing a series of tasks like :
1: Wait for base plate

2: Pick up and fit first sub assembly
3: Pick up and fit second sub assembly
4: Place complete assemble in out basket
then use the Cycle Matrix.

See below for a detailed description of the Cycle Matrix functions.

Job Matrix: Using the Jobs Matrix the emphasis is still on the work flowing in the simulation but the Jobs Matrix can make it easier to handle situations where there are a large number of options about where work can flow, including multiple repeat passes through the same work centers or many ways of performing the same task on an item of work.

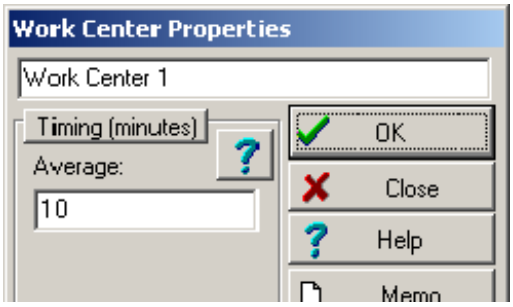
See below for a detailed description of the Job Matrix functions.

Visual Logic: Visual Logic is often used with the basic routing arrow methodology (when label values control routing) but sometimes Visual Logic is used to take over all routing but not using routing arrows and simply using Visual Logic to move work between storage bins to control what work can take place in the simulation. This is the most advanced, but also the most time consuming way to create simulations (it is the way all simulations used to be coded before simulation software was widely available). See the Visual Logic Reference Section for details of Visual Logic and its commands.

Cycle Matrix:

Cycle Matrix - How to use it.

The cycle matrix defines the cycles of activity at each work center that uses the cycle matrix. Set a work center to use the Cycle Matrix using the work center's Timing orientation dialog.



If a work center uses the cycle matrix then the work center's timing and routing decisions are controlled by the cycle matrix. To view the cycle matrix use Objects/cycle matrix in the SIMUL8 main menu

Rows in the Cycle Matrix:

Each row represents a stage in the list of tasks that work centers cycles through. Rows that relate to one work center are always collected together in the cycle matrix.

Immediately after the simulation is reset each work center using the cycle matrix will start to try to perform the first task listed for it in the cycle matrix. After a work center has completed its last task in the cycle matrix it will start again at the first row in its list.

Columns in the Cycle Matrix:

Work Center

Name of the work center. Click the cell and type the name of the work center of double click the cell and select from a list of available work centers.

If a cell is blank then it assumes the same work center as the row above it in the cycle matrix.

Task Number

This is an integer number and is usually the sequence number in which the work center does work. For example each row in the cycle matrix for a work center will have a value one higher than the pervious. However this number is only used by SIMUL8 to cross reference between rows and SIMUL8 will search all the rows for the value it needs. So there is no requirement to number the tasks sequentially.

Task numbers must be positive.

Description
Any text to act as a reminder about the task (not used by SIMUL8)

Task Type
The type of task to be performed. Type the text name of the task or double click to choose from a list of available types. The Task Type affects the meaning of some other cycle matrix columns.

Double click a cell in this column to choose one of the following task types

The following Task Types are available:

UNLOAD FROM
Take a work item onto the Work Center from the simulation object listed in the "From/To" column. If the "Work Type" and/or "Job" columns are empty then any work item may be loaded from the specified objects (using priority rules defined externally to the cycle matrix), otherwise the "Work Type" and/or "Job" columns are used to check the labels of the work items available in the specified object and only work items that match will be loaded. (Work Type must match the value in the work item's label "Work Type" and Job must match the value in the work item's label "Job")

The Time column determines the time taken to perform the loading operation.

If the work item is not available for loading then the work center will wait in this stage until it is able to start the loading time. (See Waiting% result column below).

LOAD TO
Send the work item to the simulation object listed in the From/To column. If this route is blocked then record time in the Waiting% result column - see below.

WORK
Work for the amount of time in the Time column (the time may be a reference to a distribution or calculation).

If the WORKTYPE and/or JOB columns are non-zero the labels of the work item will be tested. If they do not match, then this task will be skipped. This let you specific several different tasks depending on the nature of the work to be done.

WAIT BEGIN
Do nothing until the simulation object in the From/To column is in the State in the State column. The state can be defined with a generic state such as "EMPTY" or "LOADED" or may be a TaskNumber listed for the referenced work center elsewhere in the cycle matrix. A work center can reference itself for this type of task. For example WC1 might WAIT until WC1 is LOADED because some other work center in the cycle matrix has a task that will LOAD TO WC1.

Values in the State column must be positive.

WAITEND
Do nothing until the simulation object in the From/To column has completed the State in the State column. If the simulation object in the From/To column is not in the specified state when this row of the cycle matrix is entered, then wait until the

simulation object in the From/To column is in this state and then wait until it is complete.

"EMPTY" and "LOADED" (see WAIT BEGIN above) are not supported for this type of task.

Values in the State column must be positive.

GOTO
Instead of going to the next row in the cycle matrix go to the task number in the State column. The number may be a variable or calculation. If the result of the calculation is -1 the work center will wait in this state. If the result of the calculation is 0 the work center will go to the next task in the list whatever its task number. Immediately before the calculation is evaluated, the Visual Logic in the Visual Logic column will be obeyed.

Work Type
Can be blank or a value to specify the required value in the work item's "Work Type" label. (See Task Type LOAD above)

Job
Can be blank or a value to specify the required value in the work item's "Job" label. (See Task Type LOAD above)

From/To
For tasks that communicate with other simulation objects this column contains the name of the simulation object. Type the object name or double click the cell to select from list of available objects.

Time
Used to specify the time for the stage of the cycle

The time the stage will take in time units specified in SIMUL8's Clock / Properties menu. Alternatively specify the name of a SIMUL8 named distribution to be sampled to obtain the time or the name of a SIMUL8 Global Data Item variable that will contain the time, or a calculation to obtain the time.

State
Used to specify a stage to wait for, depending on the content of the "Task Type" column, see above.

Text or a Task Number that some work center must be in.

For example if the work center should wait until "MyOtherWorkCenter" is in its cycle matrix row that contains "26" in column "TaskNumber" then enter 26 in the State column and WAIT in the TaskType column. Alternatively if the work center should just wait until "MyOtherWorkCenter" is empty then enter "EMPTY" in the TaskType column.

Permitted values for State are any positive integer value, "EMPTY" or "LOADED". ("EMPTY" and "LOADED" are not supported for WAITEND Task Types)

Image
The image to be displayed while the work center is in this stage. Type the name of the SIMUL8 Image (from Graphics / Images list) or double click the cell in the cycle matrix to select from the available list. Leave this column blank to have SIMUL8 use the images listed in the normal Work Center/ Graphics image animation dialog.

Stage
(read only) If the simulation has been run and the work center has referenced the cycle matrix to decided what to do next then this column will indicate with and arrow the currently active stage of the cycle at the work center.

Waiting%
(read only) Results data. The percentage of time the work center has spent in this stage but not actually performing the stage because the work center had to wait to start the stage. (For example, for a LOAD stage the work center will record waiting time in the stage if the required work item is not available to load.)

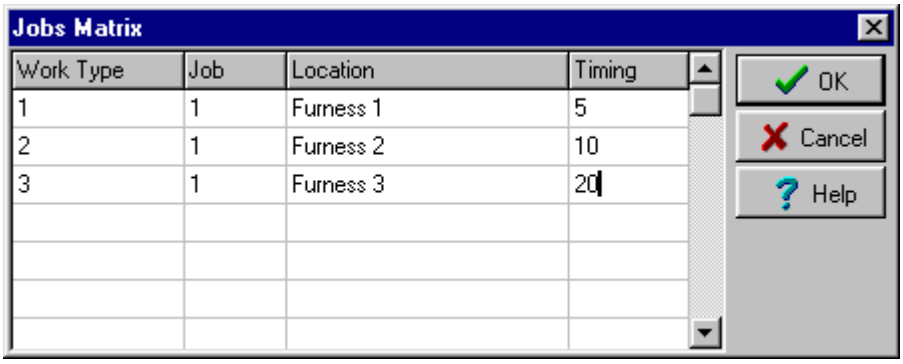
Active%
(read only) Results data. The percentage of time the work center has working at in this stage. For some stage types this will always be zero (for example WAIT type stages, where as soon as the waiting reason is satisfied the work center moves to the next stage in the cycle.)

Cycles
(read only) Results data. Number of times the cycle has been started.

Job Matrix

If a work center will feed work out to different destinations depending of the type of work then use the Job Matrix.

View the jobs matrix from the main menu: Objects / Jobs Matrix.



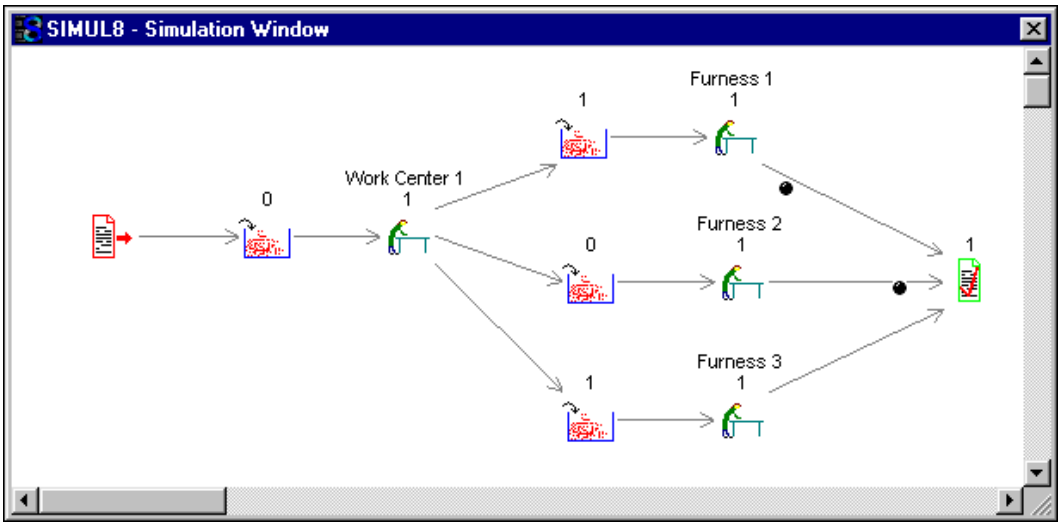
The columns :

Work Type
This is the name of a label on the work items. Its content is used to distinguish the types of work. In this case the simulation contains 3 types of work numbered 1,2 and 3.

Job
This is the name of a label on the work items. Every time the work items is processed by a work center that uses the jobs matrix for timing information, this label is automatically incremented. In this case only one work center (for each "Work Type" uses the jobs matrix only "1" appears in this column.

Location
This is the name of the work center that will do the work. Type the name of a work center, or double click the cell to choose from a list of work centers.

Timing
This is the time the job will take. Enter a number here, or double click the cell to choose the name of a distribution.



The Jobs Matrix is used for routing out at "Work Center 1" in this example. The correct route for each work item is automatically used by **SIMUL8**.

Animation

SIMUL8 contains many animation features which are designed to make your model look like the real world it represents.

This section discusses most of the aspects of **SIMUL8** which relate to animation.

When you build a model **SIMUL8** sets the model up so that you will be able to see what is happening as the model runs. In particular work items can be seen moving between objects in the model and the number of work items currently at each work center is displayed.

The speed at which work items move across the screen is dependent on the position of the speed control.

You can show more animation:

In Particular you can animate queues (storage bins) and conveyors so that you can see each work item in them as the model runs.

You can animate work centers, so that they move about as they change state (for example a work center which is working can be shown differently if it is waiting for work, or broken down). To achieve this click the GRAPHICS button inside the work center's dialog and select a different image to be displayed in each condition. See the example model: ANIMAT2.

You can also show work items which are at work centers (and if the work center's image is also displayed then the image for the work center and the work item are

automatically combined). Again, check the appropriate settings in the work center's GRAPHICS dialog.

Work centers can change the way a work item looks. To achieve this click the work item IMAGE button in the graphics dialog or use the value of labels to change the image (see the section above on labels).

All objects and work items are displayed on the screen using images. An image is a special type of object within **SIMUL8**. It has a name and information about the way it looks on the screen. Manage the images in your model using GRAPHICS / IMAGES from the main menu.

When work items move between works centers there are two different ways in which this can happen (and this affects the way in which they are animated). Travel between some types of object takes (or can take) time. In this case work items are seen moving between the objects as the clock turns and as other aspects of the model are also updated on the screen. In other cases (where work items move between objects without using simulation time) it is still possible (sometimes desirable) to see the work items "move" between these object. This can help understanding of the dynamics of the model even though such movement is actually "instant" in real life (and "instant" in the logic of the model). This movement is shown on the screen by briefly stopping the clock and moving the work item visually on the screen between the two object (although with the speed control set at around half way or more you will hardly notice that the clock has been stopped).

Objects do not have to be displayed. Often models contain objects which are included in the model purely to control the logic rather than actually physically existing in the real world. (Examples are rules which operate in the real world you are modeling - these don't "physically" exist). In this case you can set the object to "invisible".

Priority

A number of methods exist for giving aspects of your simulation model priority over other aspects.

Prioritizing Work

Normally all work items have equal priority in queues (storage areas).

The storage area dialog box allows a prioritization option. If checked you are given the opportunity to select a label, the value of which is used to prioritize the work items. The higher the value of a work item's label, the higher its priority (the nearer the front of the queue it will be placed).

Zero is the lowest possible priority (negative values have the same priority as zero). Work items without the selected label are treated as zero priority.

Prioritizing Work Centers

If two or more work centers are ready to start work (work items are available to be worked on) but they cannot start because a floating (shared) resource such as labor is unavailable then they have to compete to get this resource.

When a unit of resource becomes available the work center which gets it is determined by the work center's priority.

By default all work centers have the same priority (50). The higher the priority value, the more important the work center is in getting resources.

Priority values can be any number between 0 (lowest) and 100 (highest).

Set a work center's priority by clicking PRIORITY in the work center's dialog box. Normally priority is a fixed value but it can be changed dynamically.

The Priority of a work center can be adjusted dynamically in two ways.

1) Set the work center's priority method to "Label" and choose a label name to use. The value of this label for all work items at the heads of queues feeding the work center will be checked. The highest of these values will be used for prioritizing the work center's request for resources. These label values should be in the range 0-100. If a work item does not have the appropriate label its value will be treated as zero.

2) If the work center's priority method is set to "Fixed" then this "fixed" value can be changed from EXCEL using the SetPriority procedure (see page **Error! Bookmark not defined.**).

For other prioritization in your **SIMUL8** model see pages: 97, 106, 116.

Efficiency and Breakdowns

Both Work Centers and Conveyors can simulate situations where equipment or people work with less then 100% efficiency.

Click the Efficiency button in either the Conveyor or Work Center dialog to specify the efficiency rate.

Simply set the efficiency value (in % terms) and the typical time it takes to repair the stoppage.

Distributions used for Efficiency

With efficiency set to "AUTO " SIMUL8 calculates automatically mean-time-between-failure figures and uses negative exponential distributions for mean-time-between-failure and Erlang 2 distributions for repair time.

Detail / Auto Efficiency

Use AUTO in the breakdowns / Efficiency dialog to be able to quickly specify efficiency information. SIMUL8 does calculations for you and uses typical distributions to generate breakdowns / stoppages. If you do not know typical repair times place a ? in the repair time field. **SIMUL8** will calculate a repair time consistent with the efficiency rating you give so that typical repair times are relatively short compared with task duration.

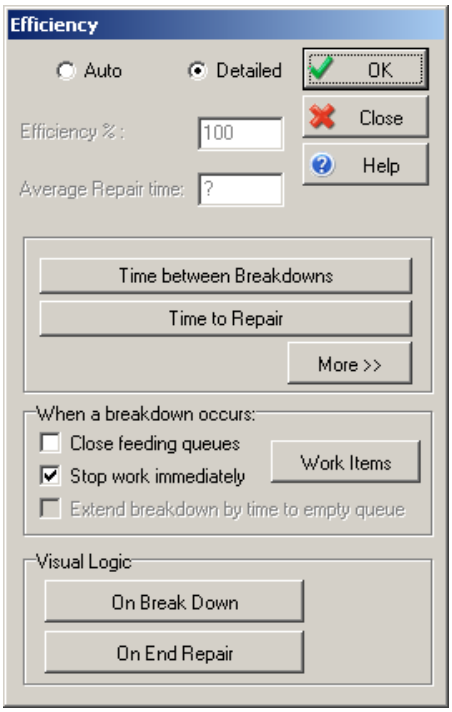
To be able to select distributions click the DETAIL check box.

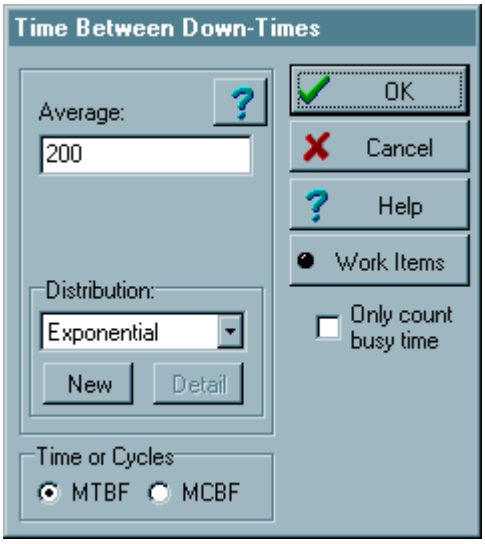
DETAIL Efficiency has 2 parameters: Time Between Breakdowns; Time to Repair.

It allows access to check boxes to control the action of the Work Center.
Close Feeding Queues: any queue feeding the work center will not accept work items during the breakdown.

Stop Work Immediately: the work center stops as soon as the break occurs

Extend Breakdown by time to empty queue; When Close Feeding Queues is selected the breakdown can be lengthened to include the time to empty the queue.





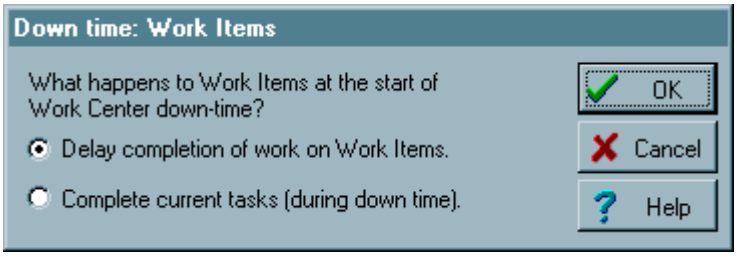
Time Between Breakdowns can be based on:

MTBF: Mean Time Between Failures. By default based on Clock time this option stops a machine working at intervals based on the distributions used.

NB: use the Only Count Busy Time check box to restrict the breakdown calculation to machine running time only.

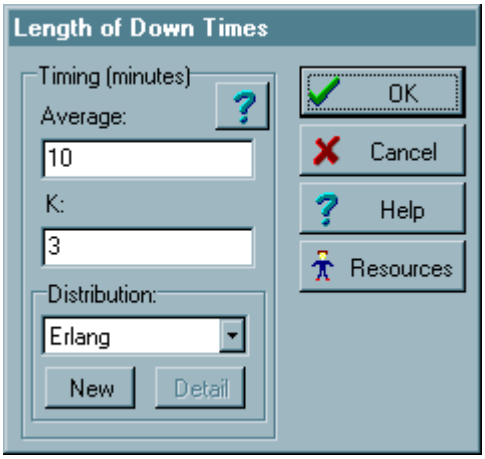
MCBF: Mean Cycles Between Failure. The number of machine cycles, or items processed between failures.

Select the Work Items option to control the action on the current work item during Down Time.


Down time: Work Items
What happens to Work Items at the start of Work Center down-time?
Delay completion of work on Work Items.
Complete current tasks (during down time).
OK
Cancel
Help

Down Time Resources

During Down Time an additional Repair Resource may be required. Select the Resource tab and select the Additional Resource to be present during a Down Time.



Stoppages - special cases

Sometimes a stoppage (or breakdown) occurs in such a way that the work center concerned will finish work on the items which are currently waiting at the work center.

At checkouts in a food store customers select the queue to enter, but if the checkout operator's lunch break time comes up while customers are in the queue, these people are still served before the operator leaves the till.

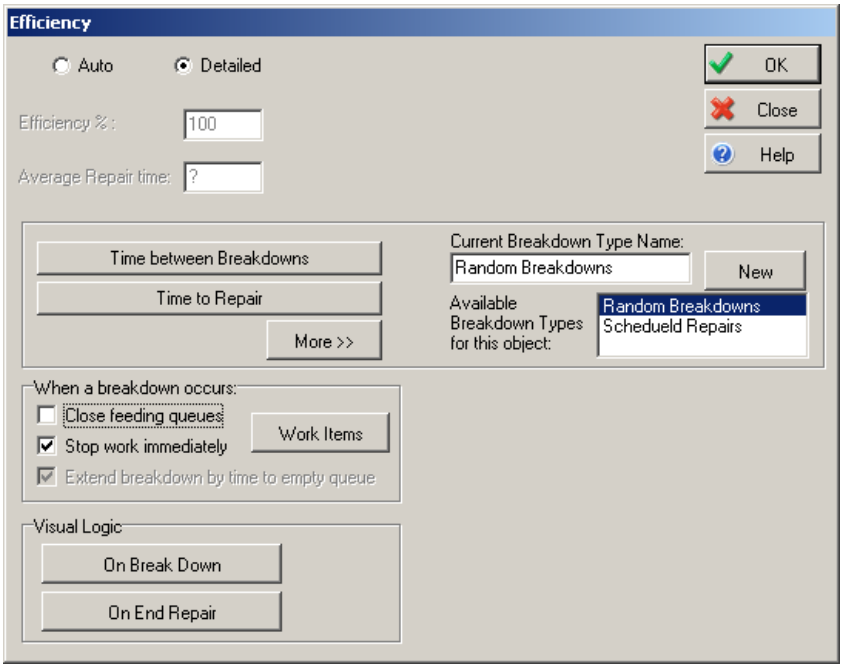
To simulate this situation switch off the "stop work immediately" check box in the breakdowns / efficiency dialog and switch on the "close feeding queues" check box. This stops customers entering the queue until the "breakdown" is over, but lets the work center continue working on remaining items.

You cannot have both check boxes off at the same time (because then the breakdown would have no effect!).A queue will not be closed if it feeds more than one object in your simulation model.

In cases where the length of the breakdown is typically short compared to the time it takes to finish processing the queue, you may want to have the breakdown timed from the moment the last work item leaves the work center (rather than the time the queue was closed). To achieve this select "Extend Breakdown time by time to process queue".

More option

The More option allows access to multiple concurrent Breakdown and Repair streams.



What this means is that multiple different reasons for a breakdown can be captured, for example different components can have different Efficiency characteristics, or there may be a scheduled Stoppage for repair as well as random Stoppages for breakdowns.

Random Numbers

Random numbers enable a simulation model to include the variability which occurs in real life.

Each place where random numbers are used within a model uses a separate stream of random numbers. This enables a change to be made to one aspect of a model, without affecting the random occurrences which will happen at other areas.

By default, when the clock is set back to the start of the simulation time, all the random streams are reset to their starting seeds. This means that a second run of the same model will produce the same results.

To change the random numbers which are used, TRIALS / RANDOM SAMPLING from the main menu and change the set of random numbers.

Random number sets are numbered. There are 30000 sets of random number streams available in SIMUL8.

Where random numbers are used

Random numbers are used in:

Distributions (unless these are "external " or "fixed")
Distributions themselves are used just about anywhere in SIMUL8 where you can specify a number for any purpose.
Routing Out (The uniform and percent options)

Auto Change

Set "**Auto change**" if you want a different set of random number streams used every time you re-run the model.

The RE-RUN button can also be used (instead of the RUN button) to achieve the same effect.

Antithetic

Select this to reverse all the random numbers. (At a low level, before random numbers are used in distributions, they are all in the range 0.00000 to 1.00000. Antithetic random numbers are exactly the same streams of numbers except they range from 1.00000 to 0.00000). Changing to the antithetic of a set of random numbers is a quick way to see if the random numbers are having a large impact on the result of a model. (But see also: Accuracy of results)

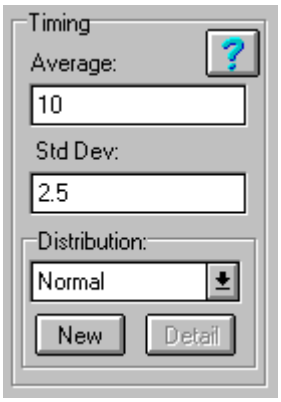
Saving Random Number Streams

Random number streams are normally saved inside your model file. This ensures that you can always return to a random number stream set and re-run the model and get exactly the same behavior from variable parts of your model. However, if you use large numbers of random number streams these can consume a large amount of disk space and memory (this tends to happen if you are using "auto change random numbers" - see page 138). You can tell **SIMUL8** not to save the random stream information (and so reduce memory/disk requirements) in the File/Preferences dialog.

Timing and Distributions

All timing and number information in SIMUL8 is given in terms of "distributions".

A distribution panel in a dialog box looks like this:



Typically this enables you to say how long a process takes, but sometimes it is used to set the value of a label, or other numbers in SIMUL8.

Distribution Parameters

In distribution/timing panels the parameters of the distribution vary with the type of distribution.

The first box is almost always the MEAN (or expected value) of the time being specified. So you can expect the average amount of time taken by a process to be the value in the first box. (But beware of the labels on the boxes - some distributions do not have MEAN as a parameter - for example: Uniform Distributions).

Distribution Type

Use the

box to select the distribution you want to use to generate the time for the particular activity to which the timing panel relates.

Click the button to see a list of available distributions (click the one you want) or click the NEW button to create a new distribution of your own.

A number of standard distributions are available in SIMUL8.

New Distribution

Click the NEW button to create a distribution of your own.

There are of a number of types:

- Named Distributions
- Probability Profile Distributions
- Time Dependent Distributions
- Time Absolute Distributions
- External Distributions
- Combination Distributions
- Label Based Distributions
- Access Information Store
- Bounded

Distribution properties

The PROPERTIES button in timing/distribution panels enables you to check and change the parameters of distribution which you have specially created for you model (including named distributions).

The PROPERTIES button is only enabled if the distribution type selection box is set to a distribution which you have defined.

Standard Distributions

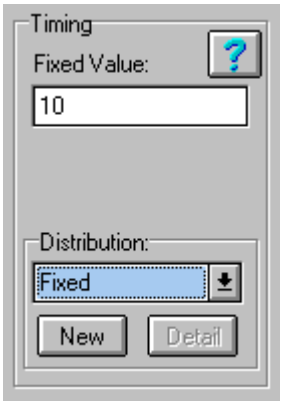
Statistical distributions provide a method of simulating the variations that occur in timing (and other numbers) in any process involving people or machines or anything in nature.

SIMUL8 allows you to create your own distributions, however certain classical statistical distributions are provided:

- Fixed
- Exponential
- Log Normal
- Negative Exponential
- Normal
- Uniform
- Weibull
- Beta
- Gamma
- Triangular
- Pearson V & VI

Fixed Distribution

A "Fixed" distribution is not a distribution! - it is a fixed value.



A sample from this distribution will always return the value in the "Fixed Value" field.

This facility enables randomness to be removed from an element of the model but also enables "Named" distributions to be used to return fixed values.

Uniform Distributions

Samples from a uniform distribution are equally spread between the **lower bound** and the **upper bound.**

The mean of the value sampled is half way between the two values specified.

No sample values occur outside this range.

Named Distributions

In **SIMUL8** you can name distributions and then use those in many places. For example if 50 different machines are work at a given rate, but you want to be able to change that rate easily, then you can tell each machine that it uses a distribution call MACHDIST, and then just change the parameters of MACHDIST.

To create a named distribution use the NEW button in the distribution panel of any of the dialogs which select distributions.

Time Dependent Distributions

In many situations the speed of a part of a system is related to the time of day. Time dependent distributions enable this to be simulated.

Time dependent distributions are made up of a sequence of "Named " distributions. Create a named distribution for each different part of the day which can be identified as requiring a different underlying distribution.

In any of the random distribution panels in dialog boxes, click NEW and then TIME DEPENDENT DISTRIBUTION, and then NEXT>>.

Click ADD to select a named distribution and to set the time of day at which it will start.

For an example, see the example file TIMEDD.S8.

Re-Sampling Overrun's between time slots

Click this check box in the Time-Dependent Distributions Time-Slot dialog if the value being sampled represents a time and if you want times sampled in the previous cell not to overlap into the current cell.

The default is OFF (not checked). Only use this facility if you are sure you need it because it can distort the results collected from your simulation if used when not required.

Example:

In this example of arrivals to a hospital's "accident and emergency" unit the time interval between arrivals is very different at different times of day. Rush hour is a very busy time.

Time Slot Start	**Average Interval Between Arrivals (minutes)**	
15:00	60	
17:30	5	(Should Re-sample Overruns)
18:30	30	

Without Re-Sampling Overruns set on the 17:30 - 18:30 period a sample taken at time 17:29 could easily result in the arrivals jumping right over the 17:30 - 18:30 period. This is because if an arrival occurred at 17:29 (in the first time slot in the above table) the time to next arrival might be sampled as 69 minutes from 17:29 - and no arrivals would occur in the busy time.

Don't use this facility if there is only a small difference between sample values in adjacent slots because to do so tends to reduce the average sample value (large numbers tend to get rejected unnecessarily).

Don't use this facility if the value sampled is not used for a time or if a sampled time will not affect when the next sample is taken. It usually only applies to distributions used for inter-arrival times (in Work Entry Objects).

External Distributions

External distributions allow SIMUL8 to collect timing information from other WINDOWS packages, rather than simply using built-in statistical distributions.

External data may come from either Excel (typically a column of data in EXCEL) or from Visual Basic. For a discussion on how to use external distributions to collect data out of a Visual Basic program see page **Error! Bookmark not defined.**).

This next section deals with using an external distribution to obtain data from Excel.

External Distributions to collect data from Excel

A typical use of this facility is to use real data collected from the situation you are modeling, rather than using an equivalent statistical distribution. This is useful if the data does not match any distribution (but see page 147) or you do not want to include any random elements in your model.

Proceed as follows:

Run Excel

Type, paste, open (read), or otherwise enter your data into a column in Excel.

In **SIMUL8** go to the dialog box where you want this data used (for example it might be a work center dialog box if the data in Excel represents the times a process has taken to be completed.

Click NEW in the timing/distribution panel. This asks **SIMUL8** to create a new type of distribution (one which is not in the drop-down list).

Choose EXTERNAL and click the NEXT button.

Now choose EXCEL and enter the name of the spreadsheet (e.g. Sheet1) and the location where the data starts (this defaults to R1C1 which is the top left corner of the spreadsheet).

Click OK.

Now when you run the model the work center etc. will make use of the data in Excel.

SIMUL8 always starts at the top of the list when you reset the clock back to the start. If **SIMUL8** detects it has reached the end of your data it goes back to the beginning of the data and re-uses it. The end of the data is signified by a blank cell (or a cell which contains something other than a number - e.g. text). Formula can appear in cells because **SIMUL8** uses the results of the formula.

If the data is in a row instead of a column click the ROW check in the dialog where you entered the start location of the data. If the data is just a single value (perhaps because you simply want **SIMUL8** to use a fixed value which you would prefer to

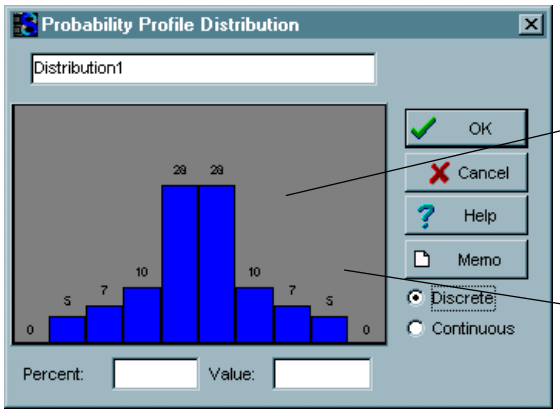
come from a spreadsheet rather than be coded directly into your model) then click the SINGLE CELL check box.

If you are using a version of EXCEL earlier than 5 then note that the naming of the spreadsheet is handled differently. With EXCEL 5 and newer, the name you place in the external distribution dialog is the name of the sheet (e.g. Sheet1). This is also the default name for the sheet in previous versions and will work with a new file. When you save your spreadsheet, exit and re-load Excel and your spreadsheet name changes to the name of the file (e.g. C:\DOCS\MYSPREAD.XLS). (It keeps the name Sheet1 in the internal workings of Excel until you exit and reload - this causes some confusion!). When you reload your spreadsheet make sure you change the entry in the **SIMUL8** external distribution dialog to read the *complete path name of the file*. This only applies to Excel 4 and earlier.

Probability Profile Distributions

These distributions can be configured entirely under your control to generate any shape of distribution desired.

Drag the blue bars up or down to change the probability (percentage chance) of each sample value occurring. (Or type in the required percentage)



Drag the bars up and down to change percentages.

Click the RIGHT mouse button for additional facilities, like locking the bars or adding more bars.

The figures above each bar are the **percentage chance** of that particular value being sampled from the distribution. (These figures are ***rounded*** to the nearest whole number in this picture).

The example model PPDIST illustrates the use of this type of distribution to set label values and then route the work items on the label values.

Click on one of the blue bars to select it and obtain its percentage and sample value figures in the edit boxes at the bottom of the window.

Drag a bar up or down to change its percentage quickly.

When you do this all other bars are adjusted so the total still adds to 100% (Unless a bar is locked).

Discrete / Continuous
Probability Profile distributions are either Discrete or Continuous.

Discrete: The value actually sampled will always be EXACTLY one of the values that appear under the blue bars.

Continuous: The value sampled will be interpolated between the sample values under the blue bars to supply any value between the lowest sample value given and the highest sample value given. This enables you to specify a shape of a smooth distribution without having to enter a percentage change and sample value for an infinite number of bars!!

A red line on the picture indicates the nature of the continuous distribution (if selected).

Click RIGHT on the Probability Profile window in SIMUL8 to be able to:

- Insert
- Delete bars
- Add to End
- Lock/unlock the percentage of a bar.
- Equalize all the unlocked percentages.
- Paste Distribution

The Multiple option allows multiples of 10 new bars to be added or deleted simultaneously, and all except 2 bars to be deleted in one entry.

Locking/unlocking the percentage of a bar:
This is useful because, having set one percentage you may want it to stay fixed while you change others (and SIMUL8 normally adjusts **all** percentage figures so that they add up to 100%).

Locking a bar still lets them all add to 100% - but the locked bars are not included in the adjustment.

Equalize sets every bar to the same percentage value (equal probability of each being sampled)
Locked bars are indicated by red percentage figures
Paste Distribution allows you to copy and paste data from Excel and transform the distribution's sample and percentage values automatically.

Label Based Distributions

A label Based Distribution lets you place information about which distribution should be used for sampling in Work Items' labels.

For example, if patients in a hospital all have to see a doctor, but the average time they spend with the doctor is dependent on their illness, then you can set up a label (called, say, "ILLNESS") which contains the type of illness they have (for example, it might contain phrases like "BROKEN BONE", "YELLOW FEVER" etc.). Then, at the Work Center for the doctor you can instruct SIMUL8 to use a distribution which will look in a label of the relevant work item to find the name of an actual distribution to sample for the time with the doctor.

Combination Distributions

A combination distribution adds together samples from a number of individual distributions.

This can be used to create special shapes of distribution or to enable unusual circumstances to be added to normal performance. For example a machine may usually take 5 minutes (with a standard deviation of 1 minute) to perform its work but on 10% of occasions this may take an additional hour. (Use a named normal distribution in combination with a probability profile distribution which has 60 minutes for 10% and 0 minutes for 90% of its results).

Time Absolute Distributions

A time absolute distribution lets you specify when you want something to happen (rather than a more usual approach of specifying how long it will be from now until the next thing happens).

This is particularly useful in situations where something happens at the same time (or about the same time) each day. For example, a mail drop may happen at around 8am and 2pm each day.

To use time absolute distributions just select NEW in any timing/distribution panel and then TIME ABSOLUTE DISTRIBUTION, then click the NEXT button.

The Time Absolute Distribution dialog lets you add a number of times the thing should happen each day.

For each time you also give another distribution name - this lets you say how much variability occurs around the time of day. For example if the morning mail drop is at 8am but the mail guy is up to 15 minutes late specify 8am and a distribution which gives values from 0 to 15 (perhaps uniform). If the afternoon mail drop is normally at 2pm but can be early or late then you might want to specify 2pm plus a distribution which is "normal" with a mean of 0 and a standard deviation of 5 minutes.

To add a new time of day click the ADD button and then type the time of day and select the required distribution.

Access Information Store

This allows direct access to the SIMUL8 Information Store. This enables items in the Information Store to be used directly for Timing, Batching and other purposes.

Bounded Distribution

The Bounded Distribution is simply a standard distribution that has additional upper and lower limits set. This prevents extreme or undesirable values being sampled.

If the distribution is sampled and a value outwith the upper and lower range is sampled then the result is not used.

If a value outwith the desirable range is sampled by the distribution then the distribution can be resampled - tick the ReSample check box. If the sample value lies outwith the bounded value and the ReSample option is not ticked then the bounded value becomes the sample value.

Example: you create a Normal Distrubution with Mean 10 and Standard Deviation 2. The Upper and Lower bounds are set to 5 and 15.
If a value more than 15 is sampled (very likely in this case) then the value 15 will be the sample if ReSample is not ticked. The alternative is that the value will be discarded and the distribution resampled until a value with in the range is produced. The same applies to the lower bound.

The Bounded Distribution can be based upon a standard distribution (eg Normal, Exponential, etc) or based on a SIMUL8 Named Distribution. Click on the New button and you can create and assign a distribution to set boundaries upon.

Shift Patterns

A **SIMUL8** shift pattern lets you say at what times of day parts of your model work. (If all of you model starts and stops at the same times then you do not need to use shift patterns - instead just set the clock to control the start time and length of each day).

To make use of shift patterns first set up a series of shifts (use Clock / Shifts).

Click NEW to add each shift (for example you might want two shifts called DAY SHIFT and NIGHT SHIFT).

Click PROPERTIES if you want to change the time each shift starts and ends each day. You can also say here which days of the week each shift applies to.

The shift properties dialog box lets you change the name of the shift (which appears in all other dialog boxes of simulation objects which make use of shift patterns).

It also lets you change the times of day when this shift is "on". Enter the start time and then the duration. Use the 24 hour clock (e.g. 5pm is 17:00).

The behavior tab lets you say what should happen to work centers which are using resources when those resources are removed at the end of a shift.

At the end of a shift there may be a reduction in the number of resources available. If some or all of the resources which are removed are currently engaged in work at work centers then the behavior tab describes what happens.

Complete Tasks - behave as if the resource was still at the work center (or stays on late after the end of the shift) and complete the task in hand - then don't start another.

Suspend but restart ASAP - stop the work and hold the work center in suspension until another resource can be found (perhaps because one finishes work at another work center).

Suspend until next shift change - as above but don't let any remaining resources be used on suspended work centers. Suspended work centers should not be considered for restart until the next shift change.

The behavior tab also lets you control what happens when shifts overlap. The default is that resources which are available in two shifts which overlap are available to the extent of the largest availability of the two shifts. You can change this assumption to summing together the two availabilities.

High Volume (BPR and FMCG) Applications

A High Volume Work Center (check the high volume box in the work center dialog) is particularly useful for Business Process Re-engineering (BPR) and Fast Moving Consumer Goods (FMCG) type applications. In these cases very high volumes of work may be processed at work centers and it may not be necessary to individually distinguish between every piece of work a work center does. For example, documents being processed by a work center may each be different but a "data entry" work center does not need to simulate them differently. This contrasts with lower volume applications where every piece of work may be very different (e.g. patients in a hospital where every patient has different labels and is treated differently depending on these labels. In high volume work centers, work also tends to be done in batches.

High volume work centers make use of the Quantity Label. Every work item type which goes through a high volume work center must have the quantity label attached to it.

High volume mode lets **SIMUL8** process large numbers of transactions very quickly in batches while still retaining the ability to consider work individually (in terms of timing etc.). The timing information you place in a work center dialog box for a high volume work center is the time it will take to work on one unit of work in the batch. For example if the timing panel in the work center dialog says FIXED 10 and the Quantity label for a work item is set to 20 then it will take 200 minutes to process the work item. If the timing panel specifies a distribution then **SIMUL8** will automatically adjust that distribution to one which is appropriate for the batch of work.

If you use batching out (from the routing out dialog) a high volume work center will split the quantity label across the newly generated work items. You can ask batching

out to use the batch size as the new value for the quantity label. In which case it will automatically generate sufficient work items to use up all of the quantity in the work item which was in the work center. (More)

If you use the percent routing out rule at a high volume work center then the work item (batch) is automatically split into as many work items as there are routes leaving the work center and the quantity label is changed to be as close as possible to the percentages specified.

Remember you do not need to use high volume mode at every work center which processes work items which are actually batches of work.

Groups

A "group" is a collection of simulation objects.

You can use a group to limit the number of work items which can be in one area of your operation or to quickly create many copies of one of your objects.

Example of the use of a group to limit the work items in an area:

If you have a machine in your operation which performs two tasks in sequence on each work item (e.g. Setup and Weld on a welding machine) it may be best modeled as two separate work centers directly connected together with no buffer between them. However, without giving **SIMUL8** an instruction, these two work centers could both contain a work item at the same time (the same machine being SETUP and WELDING at the same time!).

Simple solution: Create the two work centers and join the SETUP one to the WELD one with a routine arrow. Then select both work centers (drag a box around them) and click the right mouse button. Select "Create Group". Now go to the Group's dialog box (Objects / Groups in the main menu) and enter 1 in the "Limit Work Items in Group" box.

(Remember to also click on each work center in turn and enter the appropriate timing information for how long it takes to SETUP and WELD).

Example of use of groups to let you easily maintain copies of work centers.

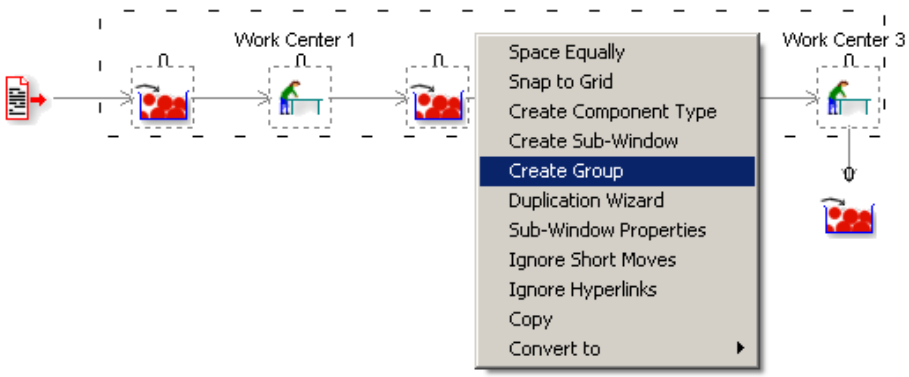
If you have a model that contains five identical machines which work in parallel, each of which can perform a given task, then create just one machine and set up all the parameters as you require.

Then create a group with just this work center in it (drag a box around the work center and click the right mouse button). You can now use the Group Dialog box to make as many copies of this work center as you like.

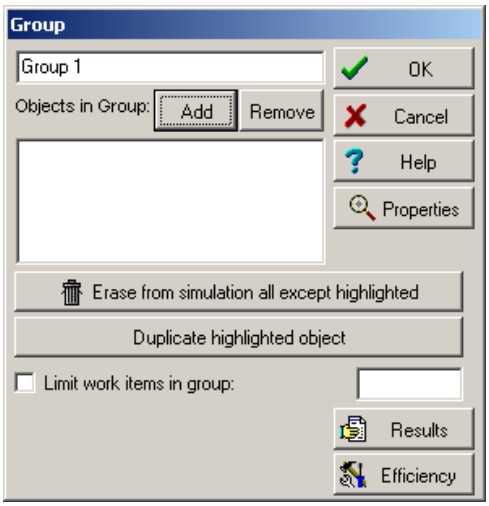
You can also use the Group Dialog Box to delete all these extra work centers should you decide you need to change some parameters of the original work center and want to be able to recopy it.

Creating Groups

Groups are created by selecting the simulation objects and clicking the right mouse button.



An alternative method is to create an empty group by using the Tools menu, Groups option and then selecting New. Next select Properties and use the Add button to select the objects to be added to the Group.



Groups are also created automatically when you use the Duplication Wizard.

The duplication wizard lets you do the equivalent of on-screen copy many times to create many copies of one or more objects (including their appropriate routing structure).

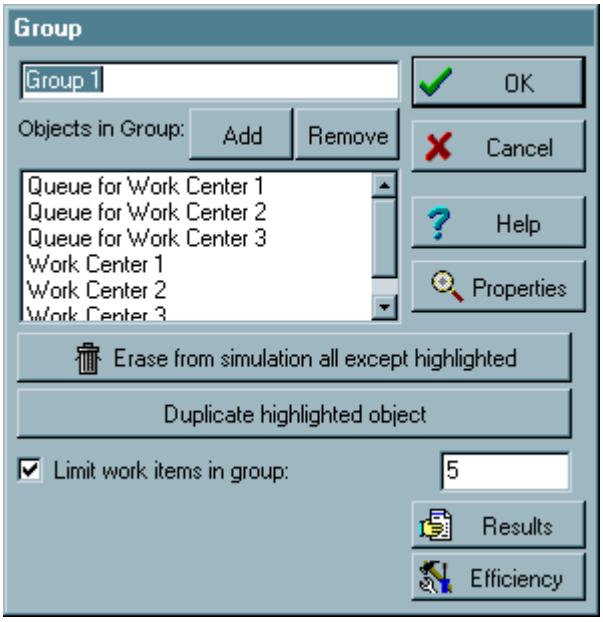
All the objects created are placed in a new group.

Access the **duplication wizard** by selecting a number of objects and the clicking the right mouse button.

Objects can belong to any number of groups.

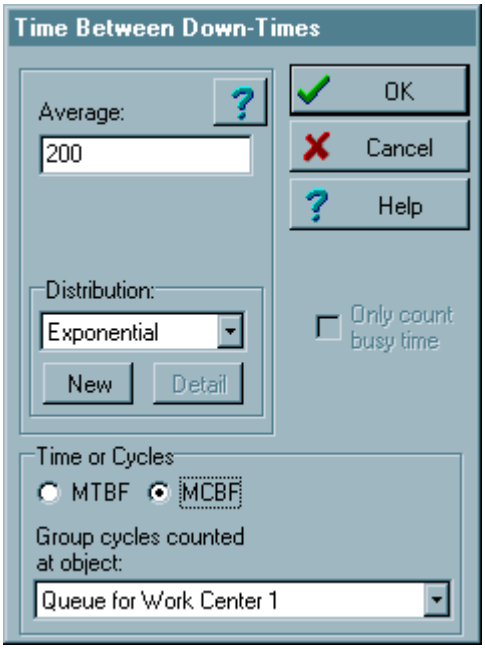
Add objects to an existing group by selecting at least one of the objects in a group and the objects you want to add to the group (then click the right mouse button).

To change details of a group use Objects / Groups in the main menu.



Results are available for the Group by using the Results button.

Efficiency for the Group can be set using the Efficiency button.

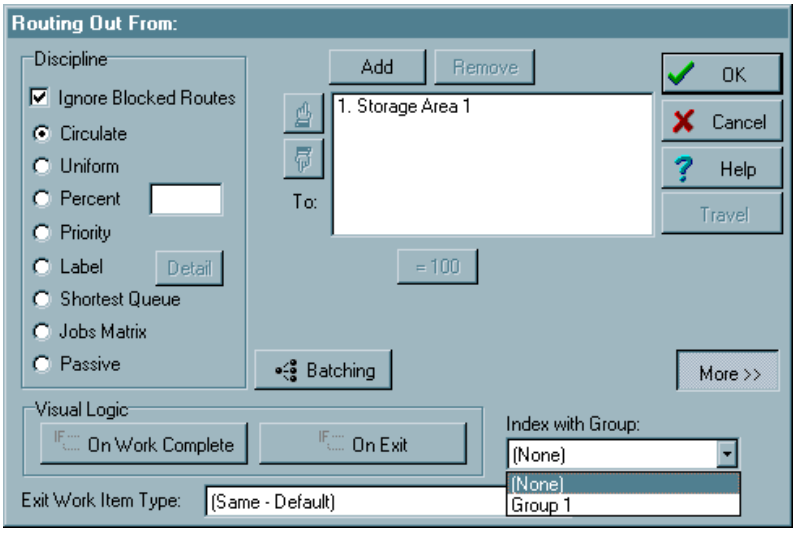


Note that the Cycle count of Mean Cycles Between Failure should be nominated to one of the Group members.

Work Centers in Groups

Using Groups, Work Centers can be made to index at the same rate. This means that the Work Centers in a Group will move items on to the next stage at the same time and rate.

For example: if Work Center A and B are instructed to Index with Groups, then the work center that finishes work first will wait and hold on to its work item until the second completes its task and routes out its work item.



Select Work Center, Routing Out, More option and the Index with Groups list box will display all the groups available in the simulation. This means that when a work center within this group is ready to send a work item to the following object it will only do so when every other work center in the group has also completed its job.

The result of this is that work items will only progress at the rate of the slowest work item or machine. This can be used to simulate Takt times in certain manufacturing operations.

Results

A number of facilities enable results to be obtained from SIMUL8 models.

Most results from a simulation run are accessed via the dialog boxes for individual Work Centers (or other screen-based objects).

For example: click on the RESULTS button in the dialog box for a storage area to view the average waiting time of items which have been through that storage area.

Results Summary Window

This is one of the most important windows in your simulation.

The results summary shows a collection of results information which you want to be able to conveniently see together (perhaps at the end of each simulation run you perform).

Access this via RESULTS / SUMMARY in the main menu.

The information in the results summary window is updated at the end of each simulation run (and also at the end of each simulation "trial").

Two different sets of figures are displayed. The most common are the results at the end of a run. Alternatively the results summary can contain the results of a trial.

The results at the end of a run

The results information displayed in the results summary window shows what happened during the run (either as an average, or as a limit value - for example when the result is something like a "maximum" size of a queue).

The result is the relevant value which was found over the length of the simulation run. For example, if the model runs for one week, and you look at a result like "average time in queue" then the result figure is the average of all the individual times which work items spent in the queue.

The results of a trial

The results at the end of a trial (see page 171) are displayed differently from the results at the end of a run.

The purpose of a trial is to check the reliability of results. At the end of just one run you have simulated one week in your organization. You have a result which is from one week. Just like real life, that could have been an average week, or a bad week, or a good week. We have no way of knowing what sort of week it was unless we run a few more of them.

A trial is a run of several weeks and the trial results summarize the results of these several weeks.

The central column of figures gives the result averaged across the weeks in the trial. This gives a guide as to what we expect the long term average to be (if we had time to do 1000's of runs).

The left and right columns give you some indication of how reliable the central (average) figure is. (In some cases the average figure may be very reliable because,

perhaps, there is little variation from week to week, on the other hand, it may be less reliable, and you need to know if this is the case....for example an average of 50 when alternate weeks swing from 0 to 100 is very different from an average of 50 when they vary only between 49 and 51!!).

The left and right columns give a prediction of the range in which the average figure will be, if we had time to do 1000's of runs. Because simulation is a predictive method, which includes the variability which is in real life, it is never possible to be 100% accurate. These left and right figures give the range in which the long term average will be on 95% of times the prediction is made. (There is an option to change this to 99% in the Trials dialog).

The more runs you do in a trial, the more accurate the predictions will become.

Adding results to the results summary

To add a new entry in the results summary go to the individual results dialog which displays the information you want (for example a storage bin's results dialog) and click (with the right mouse button) on the piece of information you want to be displayed in the results summary. This will be added to the results summary immediately and the value on the results summary will be automatically updated from the dialog box whenever a simulation run (or trial) ends.

The mouse arrow contains a letter "**R**" when it is on top of a piece of information which can be added to the results window.

You can access the individual results dialogs by clicking on the objects on the simulation window, and then on the RESULTS buttons, or, if you have the results

summary on the screen, click the PROPERTIES button to see a list of all objects for which results are available.

To remove a result entry from the results summary window either:

Click right on it again (in the same way as you did to add it to the results summary).

or

Click on its subtitle in the results window (the second column) and click the delete option in the menu that appears.

Results Compare

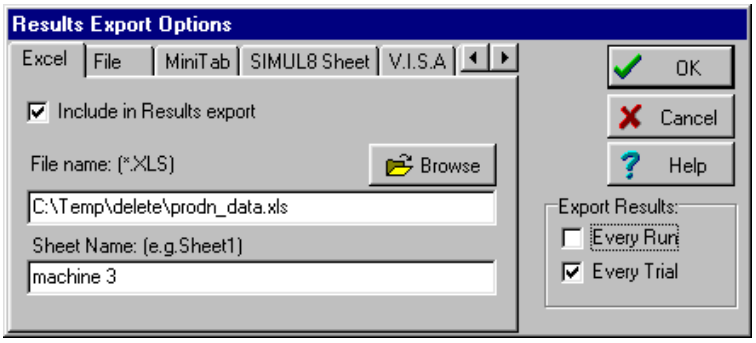
SIMUL8 collects the results of each run and stores it in the Comparison table. This is an automatic log of the results from each run.

The Compare table stores the data from the Results Summary after each Run or Trial and will store over 200 runs worth of data.

If a Trial is run then the Average value is stored in the Compare table. The results from each run of the Trial are stored, but are not entered in the Compare table. Use the Results Copy button to copy the Results of the Trial and then Paste them to another application.

Results Export

SIMUL8 results listed in the Results Summary can be exported to a variety of other compatible packages.



Check the Include in Results Export option to export the results contained in the Results Summary to the packages chosen.

Results can be exported with or without the headings used by SIMUL8, and can be exported at the end of a SIMUL8 Trial, and every run within the Trial.

Pie Charts

Pie Charts are available to show the amount of time work centers have been working, waiting, blocked or broken down. Click the button in the results dialog for the appropriate work center.

Histograms

Histograms are available showing the time work items have waited in queues and the time they have spent in the entire model (Click the button in the results dialog for the appropriate queue or work complete object).

Time graphs

Time graphs give a visual insight into the performance of part (or combinations of parts) of a **SIMUL8** model.

A time graph of the number of items in a storage area can, for example, show you patterns in a queue size, or indicate when the model will never reach a steady state (if the queue size is increasing more-or-less continuously).

To see a time-graph, click on an object on the screen (such as a storage bin) and then click its RESULTS button, followed by its button.

TIME GRAPH button on the tool bar

The time graph button is used to create time graphs of selected objects (when the model is not running) and to update preexisting time graphs, histograms and pie charts while the model is running.

Combining Time Graphs

Time Graphs from a number of different simulation objects can be combined to enable you to see the total amount of work going in the whole (or some subset) of your simulated system.

Select a number of objects on the screen.

Then click the TIME GRAPH button. A time graph is created which shows a graph against time of the total work items in the selected objects.

Exporting Time Graph Results Data to Excel

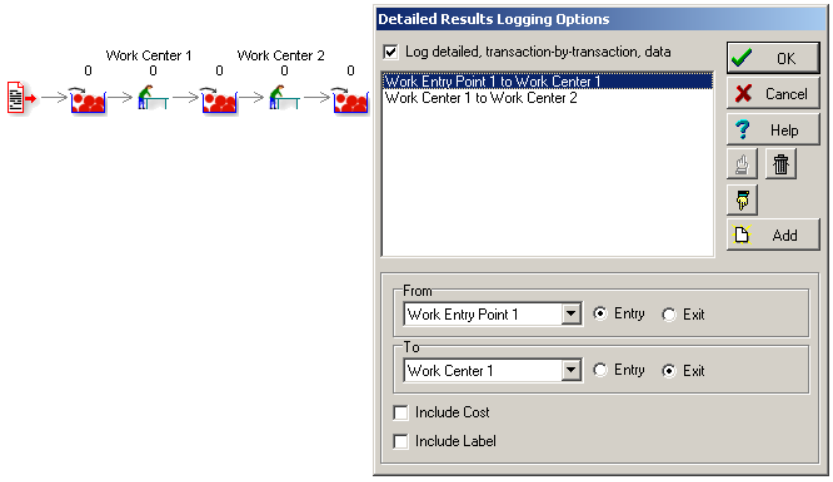
Data in Time Graphs can be exported to Excel (or other WINDOWS packages).

In a Time Graph Window, click the system menu icon (in the top left of the window) once and choose "Copy Data". This copies all the data which makes up the time graph to the WINDOWS clip board.

In Excel, click on a cell and choose Edit / Paste from the menu. The data from the time graph will be pasted into your spreadsheet where you can perform detailed analysis.

Detailed Results Logging

The Results menu, Detailed Log option allows you to collect large volume of very precise timing and Label value data.



Make sure the Log detailed, transaction-by-transaction, data option is ticked.

Use the Add button to add a start and finish point for the Result collection. Use the Up and Down hand button to alter the order that results will ultimately appear in the output sheet.

Make sure that you choose the Entry or Exit option from each object appropriately. SIMUL8 will start recording the elapsed time form the point of entry or exit to or from the first object and stop at the point of entry or exit from the second.

In this simulation SIMUL8 will record the time for each work item to pass from Work Entry Point 1 until it exits Work Center 1. The results are collected into a spreadsheet and can be viewed by selecting the Results, Detailed Log, View option.

SIMUL8 creates a Unique ID for each item for reporting purposes and this will be seen in the table, together with time elapsed between the 2 points and any Label value nominated.

Trials

A trial (or experiment) is a series of runs of the simulation model which are performed with the same settings of all the parameters in the models except for the "random numbers". As a simulation model is just like real life (it contains variability!) it is important to run a model more than once. (Was the run we did just a lucky week?). A trial gives you information about how variable the weeks are and how accurate you can expect your performance measures (results) to be.

For more information about the purpose of this see: Results of Trials

In the trials dialog you can adjust the number of runs in each trial.

The base random number stream can be changed if you want to make two trials, but use different random numbers for the two trials (This is not normally necessary). The actual random number stream sets used for the first run in the trial is the base set, this is incremented for each run in the trial.

The name of the trial will be displayed in the results summary window.

Additional Graphics

Add additional static graphics to your model (to make it look more like the real situation you are modeling, by using the graphics palette. Click the button to switch on the graphics palette (or switch it off).

Use the graphics palette to add lines, boxes, circles, bitmaps (which can be created using any graphics editor such as the Windows Paint program), text etc.

To select a graphics object (to make changes to it after you first created it) just click on it (handles will appear).

To delete graphics object, select it, then press the delete key on the keyboard.

Diagnostic Facilities

These facilities are designed to help you see what is happening inside your model as it runs. This helps you validate your model (see page 37).

Contents Button

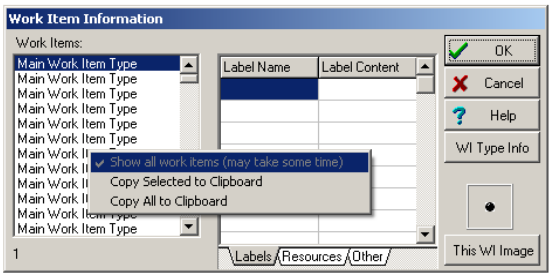
The contents dialog lets you look inside a work center or storage bin at the actual work items currently inside it. Click "Contents" in the dialog box for the particular object.

The displayed dialog box lists the work items (the names shown in the left hand list are the names of the work item type) and their labels. The work items in a queue are shown in sequence in the queue. The top of the list is the work item at the head of the queue (the next to be taken from the queue).

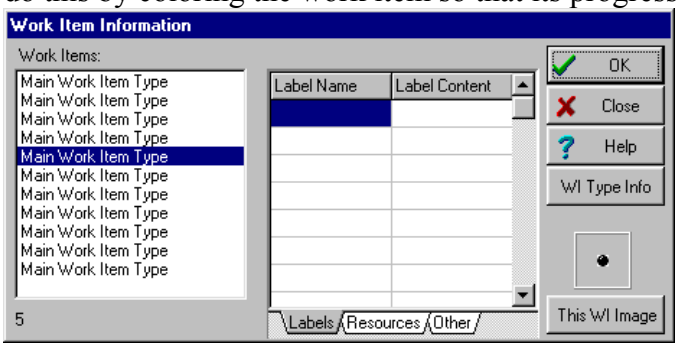
Clicking on a work item and a label name displays the values of the label.

You can also reach the contents dialog to see an individual work item. If you can see the work item on the screen while **SIMUL8** is paused (on a conveyor, in an animated queue, or just traveling between objects) just click on it while holding down CTRL and SHIFT on the keyboard.....this will take you straight to the contents dialog for that work item.

Right click in the Contents Dialog to copy the Contents information to the Clipboard. This allows precise analysis of the contents of an object.



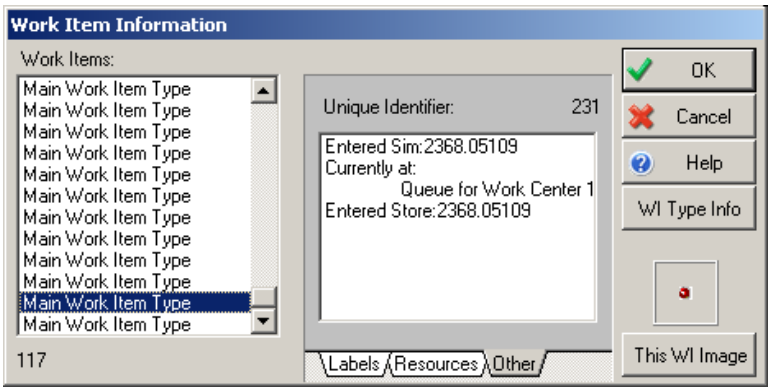
It is also possible to track the progress of a single work item. It is normally easiest to do this by coloring the work item so that its progress can be visually monitored.



After clicking the Contents button click on the "This WI Image" button and then change the color of the item (use the Paint Pot tool) or select an alternate image from the image library.

View All Work Items

To view the properties and location of every work item in the simulation select the Objects menu, Advanced , View All Work Items option.



Select the Other tab to check the location of items.

To use as a debug tool, select an item and then select the This WI Image option and chnage the color of the item. You will then be able to watch it travel through the simulation.

Simulation Monitor

The simulation monitor lets you see the detailed activity taking place within **SIMUL8** 's internal simulation engine.

Access the monitor from the main menu (Clock / Monitor Simulation).

The Future tab shows a description of the next thing which is going to happen or the next thing which **SIMUL8** will test to see if it can happen. (For example "End of job on work center" or "Try to move a work item to a work center").

The History tab shows a list of the previous 100 "Steps" (as on the Next Step tab) except that the history only shows successful steps. (For example if "Try to move a work item to a work center" was not actually able to move the work item because the work center was already busy then this is not shown in the history as it did not actually happen). The history tab also shows the times at which each step took place.

Click RUN to run the simulation while continuously monitoring the steps. Click STEP to move forward just one step. Note that Step here is more detailed than Step on the main button bar because the main button bar step only shows steps which have an effect on the simulation model (the successful steps in the simulation monitor).

SIMUL8 Assistant

The **SIMUL8** Assistant uses Expert System technology to help you get your model right. It watches the simulation model (and the way you are using it) to provide advice when it might be appropriate to do so.

How do you know the assistant has some advice? The **SIMUL8** Assistant icon on the tool bar will light up to indicate if there is some advice for you. The **SIMUL8** Wizard will move over the toolbar and puff smoke over Assistant toolbar button

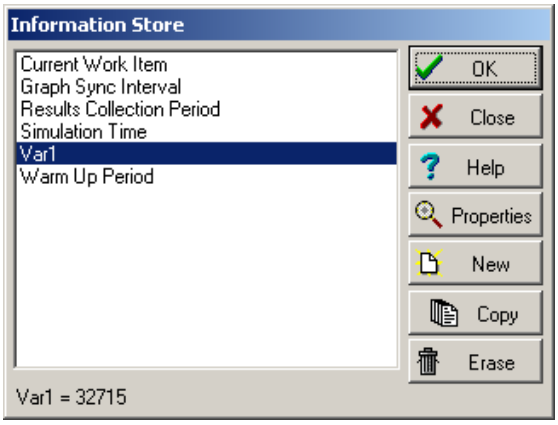
If you do not want the assistant to watch your model you can switch it off (choose Wizards / **SIMUL8** Assistant in the main menu and check the Hide All Advice check box). To turn off the Wizard use the Tools menu, Preferences option and select the Display tab.

Once you have read some advice you might decide it is not relevant to the way you use the model. In this case you can ask the assistant not to give you that advice again. You can switch off a particular category of advice completely, or you can switch it off just for the particular combination of simulation objects.

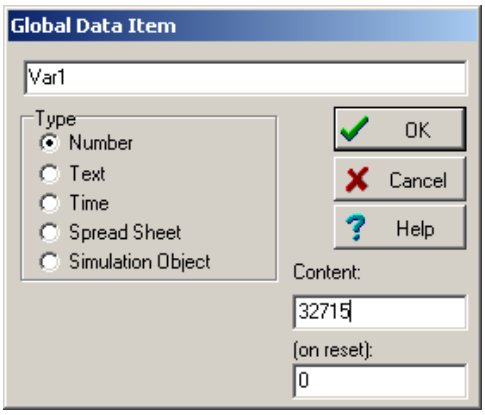
The RESET ALL button in the assistant dialog can be used to switch back on all categories of advice.

SIMUL8 Information Store

The Information Store holds data which you can use in your model. Access the store interactively using OBJECTS / INFORMATION STORE.



Click the New button to create a new Global Data Item.



You can select the type of item to create and change the starting, or Reset value as well as monitoring the current value contained in the item. You can also view the current value by hovering the mouse over the items in the main Information Store dialog.

All information store items are "global" (anywhere in the model that they are referenced will find the same value in them). This differs from labels (page 111) which have different values depending on the Work Item you are referencing. Hence they are all called "Global Data Items".

SIMUL8 provides some standard global data items in the information store:

Simulation Time - A number which is zero when the model has been reset and which (as the model runs) increases as the clock progresses. If you are working in minutes (Clock / Format) then, when the clock has run for 1 hour this global data item will contain 60.0. (If you where working in hours then it would contain 1.0)

Current Work Item - A unique identifier for the work item which is relevant inside a particular piece of Visual Logic (see page 219).

Results Collection Period - the amount of time for which result will be collected.

Warm Up Period - the amount of time for which the model will run before it starts to collect results.

Change the value of a global data item at any stage interactively (just change the value in the Content box). You can also specify the value to be placed in the global data item whenever the model is reset.

Global data items can be single variables or "spreadsheets" of data. **SIMUL8** spreadsheets are not designed to replace spreadsheet packages, they are storage places for data, or places you can create reports.

Create a spreadsheet by creating a global data item and changing its type to "spreadsheet".

Click view to review / change the data in the spreadsheet. The COPY button will copy the entire contents of the spreadsheet to the clipboard in an EXCEL compatible format. The PASTE button will replace the contents of the spreadsheet with data on the clipboard (usually pasted there from a spreadsheet package).

Single global data items can be normal text strings or numbers or they can be places that can store references to **SIMUL8**'s simulation objects.

Global Data items can be used to store references to **SIMUL8** Simulation Objects. For example a global data item called MyQueue could contain a reference to "Storage Bin 1" or "Storage Bin 2" or any other Storage Bin. On page 238 we show you how to use this type of global data item in **SIMUL8**'s Visual Logic.

Global data items are normally used from Visual Logic but you can also reference them directly from **SIMUL8** timing boxes. For example, instead of setting the average time of a work center to 10 you could set it to MACHINE SPEED where machine speed is a global data item.

Visual Global Data Items

To display a text or number global data item click the Visual Data button on the Graphics Palette Toolbar. Click at the desired window location and choose the global

data item from the drop down box. The visual display of the data is updated automatically when the data is changed.

Set the size of the box for the data by dragging the handle in its lower right corner.

SIMUL8 Spreadsheets - Formatting

SIMUL8 spreadsheets can now be formatted like in Excel, can be displayed full screen and can contain graphs, charts and even buttons that can run SIMUL8's Visual Logic. This makes it much easier to create simulations that are complete applications where users insert data and then run a simulation without the need to use other software like Excel with SIMUL8.

The new "Show Data Sheet" button on the SIMUL8 Run Tools toolbar opens a selected SIMUL8 Spreadsheet full screen. This makes it easy to have one place to store a selection of key data the user of your simulation might want to enter or review.

To set which SIMUL8 spreadsheet is displayed hold down CONTROL on the keyboard and click the data sheet button.

The sheet displayed can be set from Visual Logic using SetMainSheet and can be displayed using DisplayMainSheet.

If the data sheet button is clicked when no sheet has been selected SIMUL8 will display the first sheet that was created (in the SIMUL8 information store) - or SIMUL8 will create a new sheet if one does not yet exist.

Edit Formats Button

Most formatting and enhanced features in SIMUL8 spreadsheets are added and adjusted using the EDIT FORMATS button when viewing a SIMUL8 Spreadsheet.

Click this to enter the Formula One Work Book Designer. Exit the Formula One Work Book Designer by clicking its close button:

Formatting a SIMUL8 spreadsheet

Open the sheet from the information store and view it (or click the Data Sheet button on the toolbar).

To change column widths or row heights click and drag the boarders between the titles of the columns and rows.

To change other format features click the "Edit Formats" button in the sheet view dialog. This opens the Formula One Work Book Designer.

Use the Formula One Work Book Designer menu: Format menu to change the formats of cells etc.

Charts on SIMUL8 spreadsheets

To add a chart to the sheet use the Formula One Work Book Designer and select the cells you want charted. Click the Chart button on the Formula One Work Book Designer toolbar and drag a box onto the spreadsheet. A wizard will appear that will take you through the steps required to add a chart to the sheet.

Buttons on SIMUL8 spreadsheets

To add a button to the sheet that SIMUL8 users can click to perform operations use the Formula One Work Book Designer, click the button tool on the tool bar and drag the shape of the button on the spreadsheet.

Name the button (it must be named before it can be click and used). To name a button first select it. Once the button is selected click Objects / Name and type a name for the button (this does not have to be the same as the text displayed on the button).

Buttons start Visual Logic

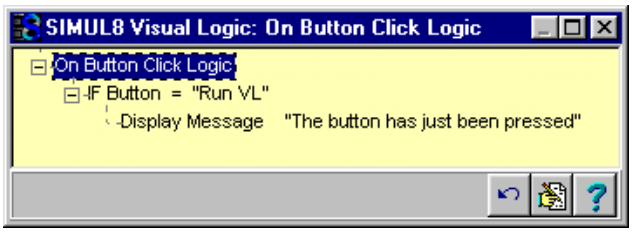
If a button is named then when you click the button SIMUL8 obeys the On Button Click Visual Logic. If you create a SIMUL8 Global Data Item of type Text named "Button" then SIMUL8 puts the name of the button (not the text displayed on the button) in to this global data item before it starts to obey the Visual Logic.

When the button is clicked the sheet is closed before the Visual Logic is obeyed. The sheet can be reopened with the Set Main Sheet and Display Main Sheet visual logic commands.

Spreadsheet Button Example:
Create a SIMUL8 Spreadsheet, click the "Edit, Formats…" button at the right of the sheet then place a button onto the spreadsheet. Name it "Run VL" by using the Object menu, Name option. Close the spreadsheet by pressing the Ok button.

Next, return to the Simulation Window, and select the Tools menu, Visual Logic events, Other Events, On Button Click. This is a special block of VL that only operates when a button on a spreadsheet is pressed.

Enter this code:


SIMUL8 Visual Logic: On Button Click Logic
On Button Click Logic
IF Button = "Run VL"
Display Message "The button has just been pressed"

You can place as many buttons as desired on a spreadsheet, provided they have different names.

When the spreadsheet is viewed and the button pressed a message box pops up.

To change the text on the button first select the button then click Objects / Options.

To select a button: Before a button is named you can just click it to select it. After it is named, to rename it you need to select it using this method: click Object / Select All, then, if more than one object is selected click the individual button you want to select.

Function Keys

Button Click Logic can be used to assign Visual Logic functions to keyboard Functions keys.

Assign the text "SFn" where n is the number of the Function key, hence "SF3" for the F3 key, and "SF4" for the F4 key, instead of the button name.

The Function key is activated by holding Shift and then pressing the Function key.

Custom Dialogs

Custom dialogs allow **SIMUL8** to be tailored to the specific needs of a business.

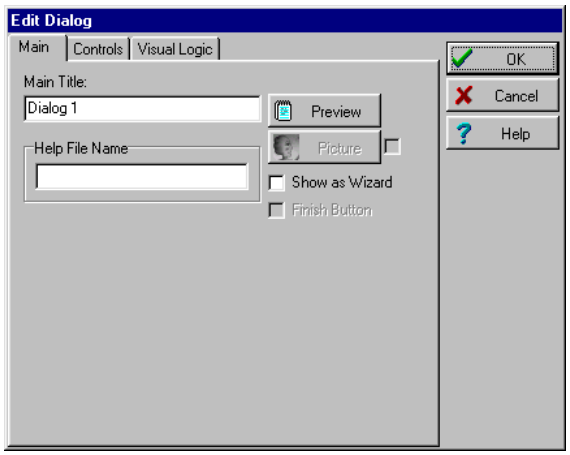
Custom dialogs can appear when Components are clicked (replacing their properties dialogs), as new menu items on the **SIMUL8** menu bar, when simulations or templates for simulations are opened, or at any time driven by Visual Logic.

Custom dialogs can display **SIMUL8** information store data and allow information store data to be changed by the user. This makes it very easy for someone to use simulation on a daily basis without any understanding of how to build simulations (and without the simulation builder having to use external packages like Visual Basic or EXCEL).

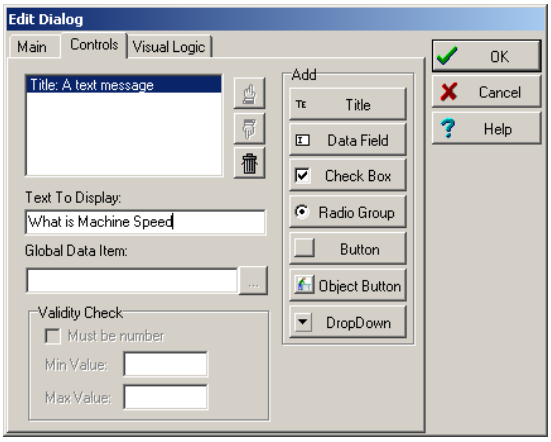
To create a custom dialog that allows the user to change a Global Data Item called MachineSpeed (that can then be used anywhere in the simulation)

1 On the main menu click Tools / Dialogs / List and Create

2 Click NEW to create a new empty dialog and enter the dialog editor

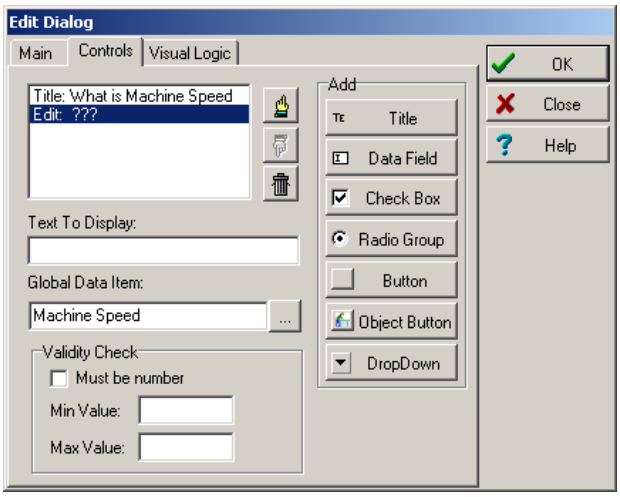


3 Click Controls, then TITLE and enter text saying "What is Machine Speed?"



4 Click DATA FIELD and enter the name of the Global Data Item (Machine Speed).

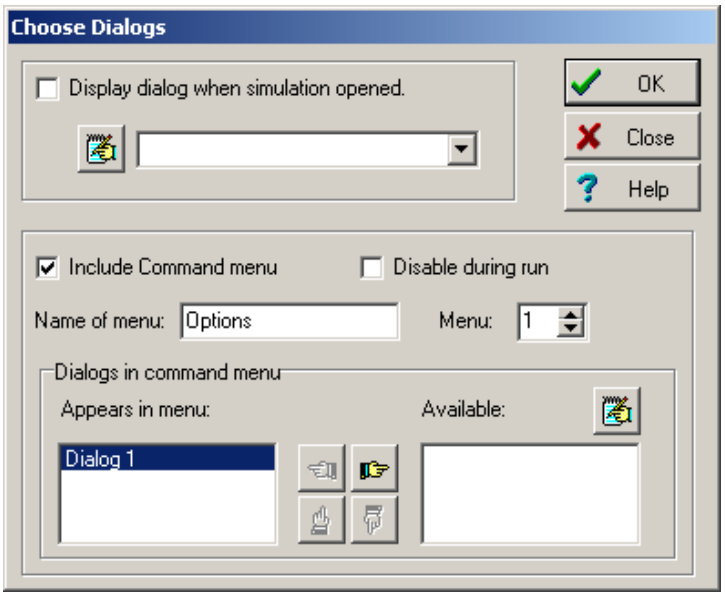
(Or you can click the ... button to get to the formula editor so you can select a Global data item.)



4b If necessary you can check the validity of numeric inputs by ticking the "Must be Number" option and entering the minimum and maximum acceptable values.

5 Click OK back to the main menu and choose Tools / Dialogs / Setup Menu

6 Click the name of the dialog you created and click the Left Hand button to move the Dialog to the left hand panel.

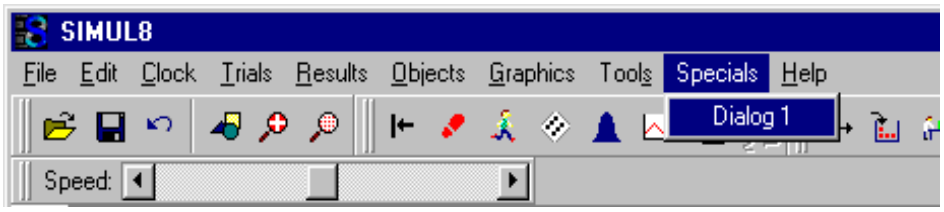


7 Type a name for your new menu and check the INCLUDE COMMAND MENU check box. This creates a new Menu item on the Toolbar between the Tools and Help menus

8. If the user of the simulation is to be able to make pause the simulation to make changes, through the dialog, during a run do not check "Disable during run". This allows the user to select he menu option and automatically pause the simulation while the menu item is being accessed.

You can create multiple new menu items. Specify the Number and attach the desired Dialogs to each new menu option.

If a menu is not associated with any Dialogs it is not displayed.
8 Click OK and your new dialog is available to users.



For special setting and use of Global Data Item variables before of after the dialog is used click the Visual Logic buttons in the Dialog Editor.

Combo Boxes (Drop Down lists)

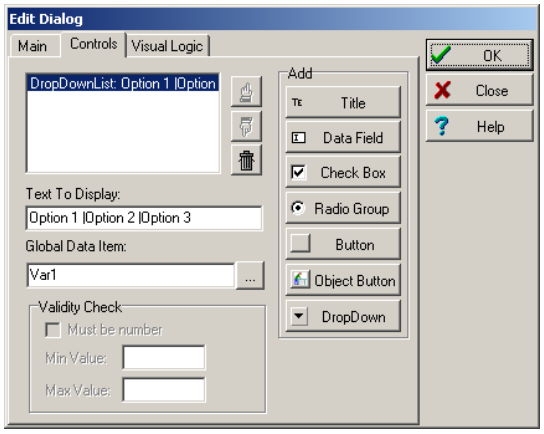
A Combo box lets a user choose from a number of alternatives.

Combo Boxes are the drop down list boxes that are commonly used in applications. They let a user easily make choices between a number of alternatives and are space efficient when placed upon SIMUL8 dialogs.

Create a SIMUL8 Custom Dialog. Insert a Combo box by selecting the Drop Down option button.You wil be required to associate a Global Data Item with the Drop Down item. This Global Data item must be a Text item.

Add new Option to the list by entering text and separating it from any existing entry with a vertical bar .

When viewed you will see a drop down list box added to your dialog.



Wizards

Wizards appear in many software package but in SIMUL8 you can quickly create your own. SIMUL8 dialogs (available in version 5 and above) can now be set up as wizards that let the user easily click through a series of steps. The most common use is in setting up a new simulation based on a template.

In the Tools / Wizards / List and Create you can create a dialog. Once the dialog properties are displayed check the Show as Wizard check box.

This makes additional options available to make use of NEXT and BACK buttons.

Wizards have been used to construct the SIMUL8 templates in the Templates directory. Use these are examples of how to create your own Wizard based simulation templates.

Debugging

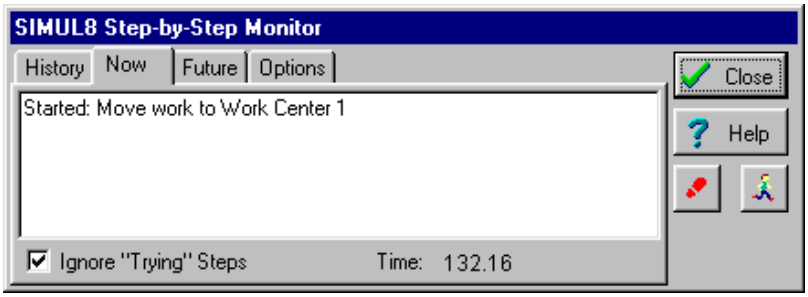
NB See also the section on the Watch Window!

Checking that a simulation is doing what it is designed to do needs some special tools. SIMUL8 provides 3 main ways of checking the simulation's operation:
1: The Simulation Monitor
2: Visual Data
3: Visual Logic: Disable Current Line
Stop (debug) current line
Show message

There is also a facility to view the content of a file as text, so that key phrases or words may be searched for.

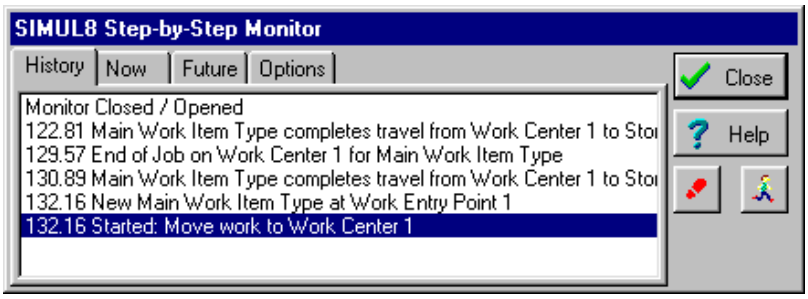
Simulation Monitor:

The Simulation Monitor is accessed through the Clock Menu, Simulation Monitor option. It shows every event that has happened, is currently happening, or is due to happen.

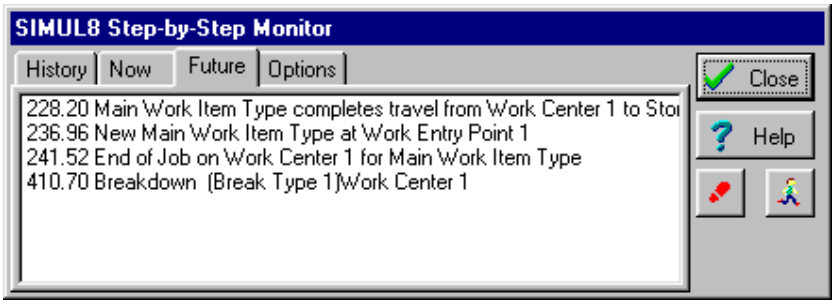


Open the monitor and press the Run button. Each event will be shown on the Now tabbed page as it occurs and the time that it occurs. "Ignore Trying Steps" reduces the number of items shown by ignoring steps that are attempted but which prove to be unsuccessful.

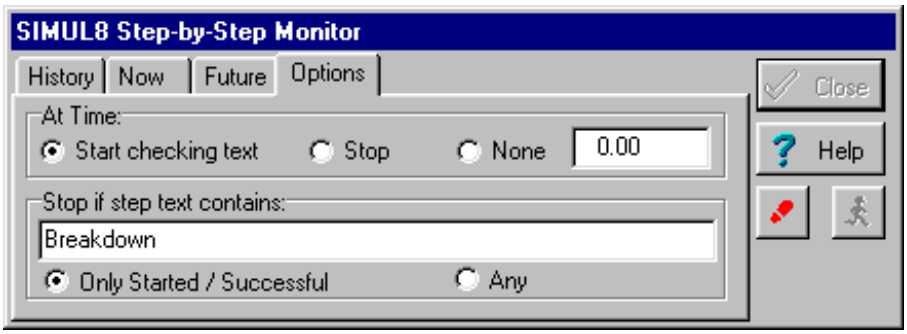
The History tab shows all the successful events that have occurred, so that it can be determined precisely when an event took place.


SIMUL8 Step-by-Step Monitor
History
Now
Future
Options
Monitor Closed / Opened
122.81 Main Work Item Type completes travel from Work Center 1 to Stor
129.57 End of Job on Work Center 1 for Main Work Item Type
130.89 Main Work Item Type completes travel from Work Center 1 to Stor
132.16 New Main Work Item Type at Work Entry Point 1
132.16 Started: Move work to Work Center 1
Close
Help

The Future tab shows any events that are scheduled to happen. This would include new work items arriving through a Work Entry Point, and any breakdowns that can occur.

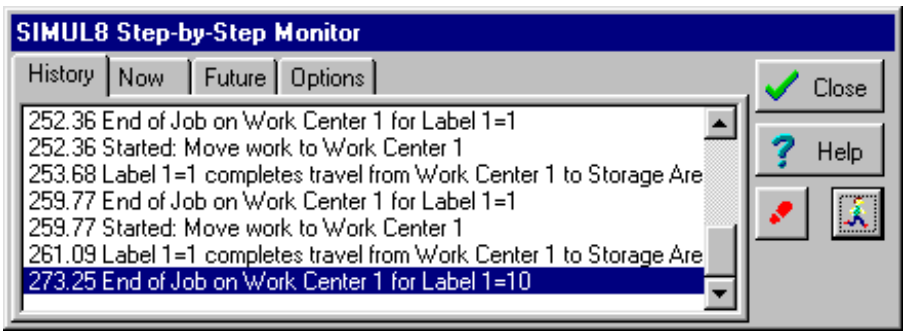

SIMUL8 Step-by-Step Monitor
History
Now
Future
Options
228.20 Main Work Item Type completes travel from Work Center 1 to Sto
236.96 New Main Work Item Type at Work Entry Point 1
241.52 End of Job on Work Center 1 for Main Work Item Type
410.70 Breakdown (Break Type 1)Work Center 1
Close
Help

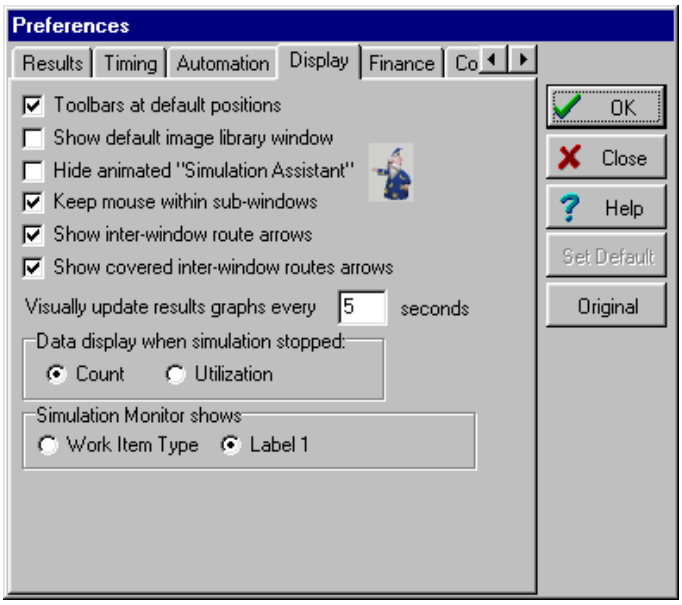
It is also possible to stop the simulation whenever a certain time is reached, or certain text is displayed in the monitor. For example if you want to observe Breakdowns as they occur type Breakdown into the field:



The simulation will stop and indicate that this event has been reached.

The Monitor can also show values of a nominated Label, rather than Work Item Type. In the Preferences menu select the Monitor option for Label and select the Label you would like to monitor.


SIMUL8 Step-by-Step Monitor
History
Now
Future
Options
252.36 End of Job on Work Center 1 for Label 1=1
252.36 Started: Move work to Work Center 1
253.68 Label 1=1 completes travel from Work Center 1 to Storage Are
259.77 End of Job on Work Center 1 for Label 1=1
259.77 Started: Move work to Work Center 1
261.09 Label 1=1 completes travel from Work Center 1 to Storage Are
273.25 End of Job on Work Center 1 for Label 1=10
Close
Help

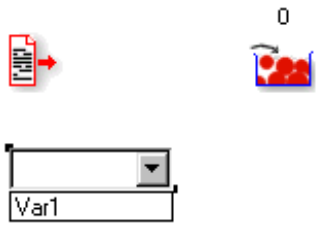


Visual Data

You'll find the Visual Data tool on the Graphics toolbar.

Visual Data allows you to display the current value of a Global Data Item on screen. This can be used to track values, and GlobalData Items can be added to the Results Summary (Right Click on them in the Information Store).

To add a Visual Data item to your Simulation Window select the Visual Data tool from the toolbar, and then click on the Simulation Window. Choose the Visual Data item to display from the drop down list.

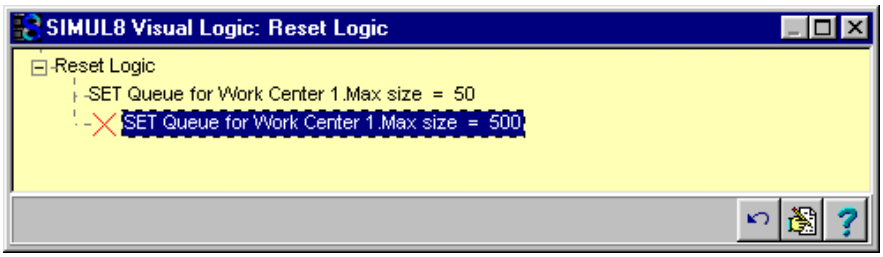


Visual Logic:

Visual Logic contains 2 main Debugging tools: Stop (Debug) at Current Line, and Disable Current Line.

Disable Current Line

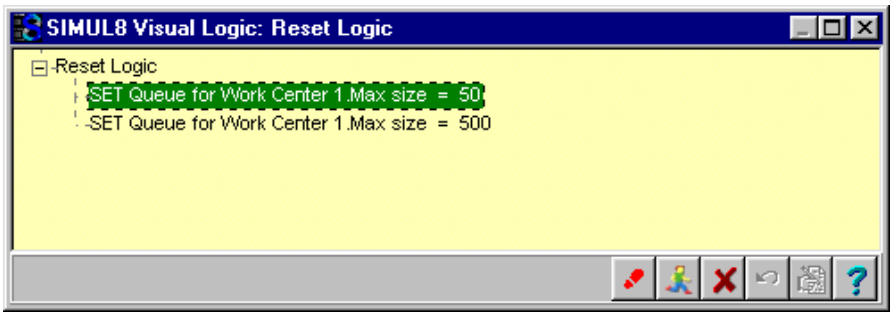
Disable Current Line simply "Comments Out" a line of Visual Logic, so that you can test if it has the desired effect when running. For example, in this block of code:


SIMUL8 Visual Logic: Reset Logic
Reset Logic
SET Queue for Work Center 1.Max size = 50
SET Queue for Work Center 1.Max size = 500

The second line of code (with the large red X at the beginning of the line) is disabled and will not run.

Stop (Debug) at Current Line

This is a very powerful debugging feature. The debug feature will colour a line of Visual Logic, indicating that this is a breakpoint.


SIMUL8 Visual Logic: Reset Logic
Reset Logic
SET Queue for Work Center 1.Max size = 50
SET Queue for Work Center 1.Max size = 500

When SIMUL8 encounters this line of code it will stop, and display a message. Pressing the Step button or F8 function key allows the code to progress, line by line. The code can be "watched" as it executes to make sure that it is executing as designed.

SIMUL8 Simulation Templates

A **SIMUL8** simulation template is a pre-built simulation that is set up with custom dialogs to make it very easy for people new to simulation to get immediate business results. But the template idea still allows them to change the simulation to match their individual business.

To open a template to start tailoring it to your needs click FILE / OPEN TEMPLATE. This is opened like a new simulation. If you click save you will need to give it a new name and save it in a new location.

Some templates have dialogs that open automatically asking you to enter configuration parameters. Other give instructions when opened explaining what facilities are available.

For additional templates look at http://www.SIMUL8.com/templates/

Building SIMUL8 simulation templates

Once you have built a simulation that may be useful to other users click FILE / EXPORT / SIMUL8 TEMPLATE. **SIMUL8** creates the template in the **SIMUL8** template directory. Files in this directory can be sent to other users for installation into their **SIMUL8** template directory.

SIMUL8 SQL

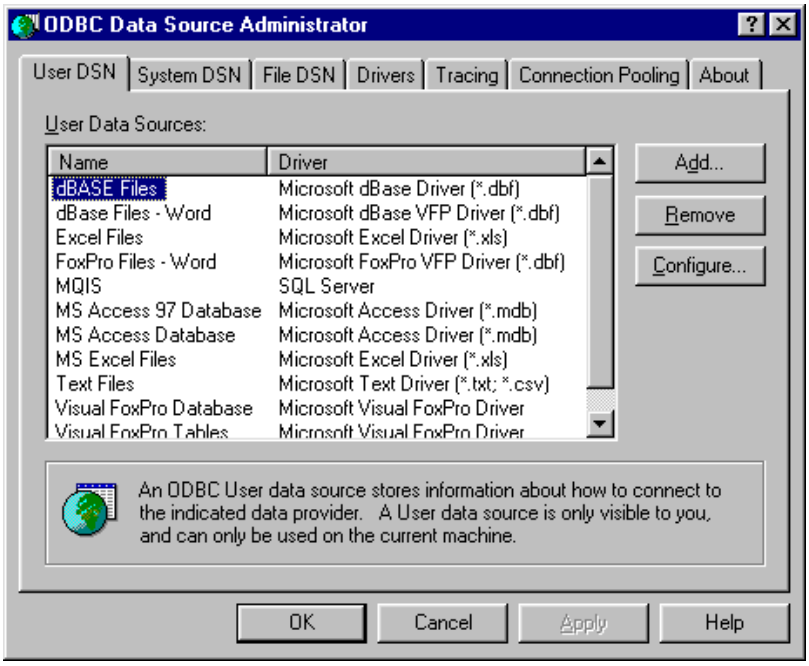
Available as a Plug-In or as part of the Professional edition, SQL (Structured Query Language) is a language used to query data sources, normally databases such as Microsoft Access, but also including other SQL compatible packages, such as Microsoft Excel.

SIMUL8 adheres to the conventions set out in the SQL99 standards approved by the International Standards Organization (ISO).

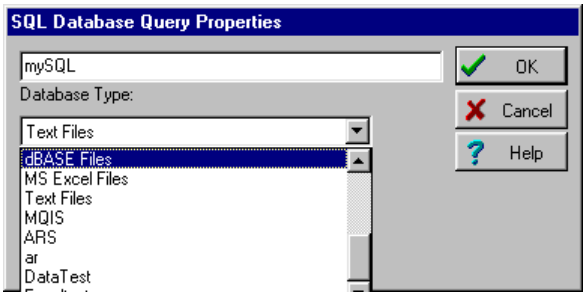
SIMUL8 SQL is an extremely powerful way of reading and writing data to and from a data source. SIMUL8 can create new records, and update or delete existing ones. Using an external data source reduces the memory overhead for SIMUL8, and allows access to huge volumes of "real" data, possibly stored on a separate machien or network drive.

SIMUL8 SQL requires a valid "alias" to exist in the machine running SIMUL8. An Alias is commonly known as a Data Source Name.

New Data Source Names can be created by using the ODBC Data Source Administrator suppied as part of Microsoft Windows 95, 98, NT, and 2000. Access this through the Start menu, Settings option, then select the Control Panel, ODBC Data Sources (32 Bit).



Use the Help topics supplied with the ODBC Data Source Administrator for help in creating the appropriate Data Source Name. Once the DSN exists it will appear in the Objects, SQL Databse Queries list in SIMUL8. Instruct SIMUL8 to look for the datasource by pressing the New button in the SQL Database Queries dialog.



See Also:

- Complete SQL Insert or Update
- Get From Database Field
- Insert into SQL Database
- Open database
- Set Field Text
- Set Field Number
- SQL Command
- Update SQL Database

VISIO Support

SIMUL8 now supports VISIO files so that VISIO owners can import any flowchart they have created with VISIO 5 or above. The flow chart is intelligently read by SIMUL8 and converted to a simulation of the process described by the flowchart. Its a very fast way for any flowchart user to find out how their planned operation will work in practice.

VISIO (www.visio.com) is often used to create flowcharts. Flowcharts are static representations of how things (like people, products or transactions) will flow around a planned process. These charts do not take account of the time that each item spends in each process. They also to not take account of the time that each item flowing through the process will arrive at each stage and whether the other resources required for the stage to start will be available at that time. Simulation does this and has many other benefits.

Importing from VISIO

Recent versions of VISIO will support the new Microsoft XML standard, making it easy to import and export data between **SIMUL8** and VISIO.

Use the File menu, Open, or File menu, Import option, Visio to select a VISIO drawing saved as .vdx (VISIO's XML format). This imports the file to **SIMUL8** with default simulation settings. Make changes to the file and then save as VISIO's .vdx file type by either using the File menu, Save As option and selecting the appropriate file type, or using File menu, Export option, VISIO and select .vdx from the list.

This allows VISIO drawing to be opened and saved by **SIMUL8** and simulation specific information to be added to the file. When changes are made in VISIO the simulation information in the file is retained, so that when the file is re-opened in **SIMUL8** all information relating to **SIMUL8** is still present and does not need to be re-entered

Importing from VISIO without XML support

If your version of VISIO does not support XML or .vdx then use this method:

To convert any VISIO flowchart to a simulation :

In VISIO click the "Animate in SIMUL8" button* on the main VISIO toolbar to automatically convert the current open flowchart to a simulation in SIMUL8.

* (Note the "Animate in SIMUL8" button is only on the VISIO toolbar if SIMUL8 2000 was installed on the PC after VISIO was installed. If you installed VISIO after SIMUL8, then reinstall SIMUL8 to add the button to VISIO)
Or

In SIMUL8 click File / Import / VISIO / VISIO Drawing and choose the *.VSD file.

To see the simulation animated click the RUN button in SIMUL8.

SIMUL8 works with VISIO Standard 5.0 and above.

SIMUL8 has default information for every aspect of data required in a simulation (so SIMUL8 adds all this data to the VISIO flowchart automatically as it is imported).

To change any aspect of the simulation data click on the simulation objects in SIMUL8's simulation window or use the other SIMUL8 features described elsewhere in the SIMUL8 documentation.

XML Support

SIMUL8 now supports the XML standard.

Use the File menu, Save As option and select XML to save a **SIMUL8** file as the XML format ready for editing in an XML editor or for import to another application.

Use the File Menu, Open, and select XML as the file type to import a file saved as XML.
Both the Open and Save as XML options are available under the File menu, Import and Export options.

For more details on **SIMUL8** XML file formats, simulation XML standards, or XML tags contact Team7@ **SIMUL8**.com

Exporting back to VISIO

SIMUL8 can save data from the simulation into VISIO's drawing file so that changes can be made to the drawing in VISIO and then the data reused when the drawing is later imported back to SIMUL8.

In SIMUL8 click File / Export / VISIO / Export to Imported Drawing. The data is then sent to VISIO and added to VISIO's shapes as a special data category in each shape's "shape sheet". Click File / Save in VISIO to save this data back to disk in VISIO.

Solution XML

Using SolutionXML in SIMUL8's XML files

This section assumes you understand the basic concepts of XML files. A good reference text is XML Black Book, Natanya Pitts.

SolutionXML is a idea supported by a number of software products, it enables you to embed your own XML data inside SIMUL8's XML and have SIMUL8 preserve your data when XML files are open, read, saved etc.

In addition, in SIMUL8, the content of your SolutionXML can be read and written via COM.

SIMUL8 also saves your SolutionXML data and tags inside S8 file types. This means it is also a very valuable feature for COM applications that don't use XML files.

Where are <SolutionXML> tags allowed?

<SolutionXML> tags are allowed immediately below the SIMUL8 XML nodes (tags):

<SimulationObject>	- used for your own XML that relates to each simulation object.
<SimulationParameters>	- used for your own XML that is general to the entire simulation.

See the next page for an example.

Example:

```
<SIMUL8XML>
   <SimulationParameters>
      <Trial>
         <Title></Title>
         <Runs>5</Runs>
         <SendToVISA>No</SendToVISA>
      </Trial>
      <SolutionXML>
         <MyData>data not related to objects</MyData>
         <SomeMoreofMyData>more data</SomeMoreofMyData>
      </SolutionXML>
         .
         .
         .
   </SimulationParameters>
         .
         .
         .
   <SimulationObjects>
      <SimulationObject Name="Work Entry Point 1" Type="Work Entry Point" ID="1">
         <Index>1</Index>
         <Window>1</Window>
         <SolutionXML>
           <MyData>data for this object</MyData>
           <SomeMoreofMyData>data for this object</SomeMoreofMyData>
         </SolutionXML>
         .
         .
         .
      </SimulationObject>
      <SimulationObject Name="Queue for Work Center 1" Type="Storage Area" ID="2">
         <Index>1</Index>
         <Window>1</Window>
         <SolutionXML>
           <MyData>data for this object</MyData>
           <SomeMoreofMyData>data for this object</SomeMoreofMyData>
         </SolutionXML>
         .
         .
         .
      </SimulationObject>
         .
         .
         .
   </SimulationObjects>
         .
```

```
        .
        .
</SIMUL8XML>
```

All data within the <SolutionXML> tags must be "correctly formed XML".

We recommend that, when reading, adding and changing XML within <SolutionXML> tags you contain all your data within a node (tag pair) that uniquely identifies your data, and that you preserve any other data within the <SolutionXML> tags. This means that other people can also use the <SolutionXML> tags and their data will be preserved along side yours. For example:

```
<SimulationObject Name="Work Entry Point 1" Type="Work Entry Point" ID="1">
   <Index>1</Index>
   <Window>1</Window>
   <SolutionXML>
     <MyCompanysXML>
       <MyData>data</MyData>
       <SomeMoreofMyData>data</SomeMoreofMyData>
     </MyCompanysXML>
     <othertag>
     </othertag>
     <othertag>
     </othertag>
   </SolutionXML>
   .
   .
   .
</SimulationObject>
```

Access to SolutionXML from COM

COM Objects S8Simulation and S8SimObject have read/write properties "SolutionXML". Use these properties from COM/ActiveX to read or write the SolutionXML that has been read from a SIMUL8 XML file. If the user clicks SAVE (or you use SAVE from COM) the changed SolutionXML will be written back to the current simulation file.

SDX Support

EAI's FactoryCAD adds significant functionality to AutoCAD. FactoryCAD has objects that represent machines, conveyors etc in the factory represented by the diagram. EAI have pioneered a new standard of file format: Simulation Definition Exchange (SDX) that allows these objects to be exported to simulation software. In addition to importing SDX files, SIMUL8 also exports SDX files so that simulations created in SIMUL8 can be exported to other simulation systems that read SDX.

Importing FactoryCAD's objects into SIMUL8

To import objects from FactoryCAD first save the FactoryCAD drawing as an SDX file. Then, in SIMUL8, click File / Import / SDX and choose the *.SDX file.

To see the simulation animated click the RUN button in SIMUL8.

After the objects are imported SIMUL8 may add some additional simulation objects. For example FactoryCAD does not have some objects that are important to get a simulation started (like a definition of the rate at which work arrives in a factory).

The FactoryCAD layout is automatically zoomed to use the full space available in the SIMUL8 simulation window.

Exporting to other simulation systems

SIMUL8 can export SDX files. This means that your simulation in SIMUL8 can be converted to other simulation systems.

Click File / Export / SDX and specify a file name.

Note: Other simulation systems that support SDX are note likely to support all the features that SIMUL8 support, also, the SDX file format does not support all the features that SIMUL8 supports, therefore some loss of information will occur once the simulation has been imported to another simulation system. Nevertheless this feature does increase the speed at which simulations can be converted between simulation packages.

AutoCAD Drawings

AutoCAD drawings referenced in SDX files are automatically imported and set up as background graphics on the main simulation window.

AutoCAD drawings can also be imported to SIMUL8 using File / Import / AutoCAD

Visual Logic Extension User Guide

Visual Logic Introduction

Visual Logic lets you add detailed rules to your simulation model. It lets you tell the simulation exactly how to behave like the real operation you manage.

The difference between Visual Logic and "programming" is that in Visual Logic you are guided, step-by-step as you choose what logic to use - so you cannot get the syntax wrong.

This guide assumes you understand the most **SIMUL8** concepts (but not the external extensions like the VB and EXCEL extensions).

The section Visual Logic Basics (page 217) explains how **SIMUL8** obeys the Visual Logic you give it. (What the commands do to the work items and simulation objects etc.)

The best way to learn Visual Logic is by example. The section Building Visual Logic (page222) will show you examples of Visual Logic in action (and refers you to models in the **SIMUL8** Examples Directory). It also guides you through the Visual Logic editor dialogs.

The section "Visual Logic Commands by Category" gives a list by category of the facilities available in Visual Logic.

The section "Visual Logic Command Details" gives an alphabetical detailed list of all the Visual Logic facilities along with specifications of how each facility operates.

First we take a look at how Visual Logic fits into your simulation model and also give an overview of what it looks like.

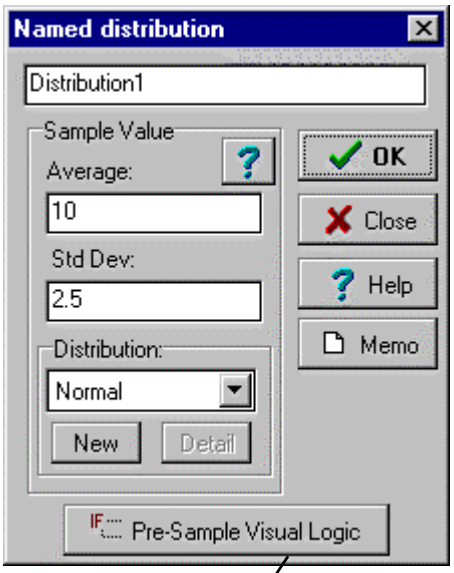
Visual Logic Structure

This section deals with understanding where Visual Logic (VL) fits into your model. We also take a look at VL. We show you what it looks like. We show you how it is VL's structure which makes it easy to use, easy to read and easy to write.

The structure of Visual Logic in your simulation model.

VL does not appear as one large stream of code in your simulation model. It is structured and divided into appropriate places that you simply access where you need to use them.

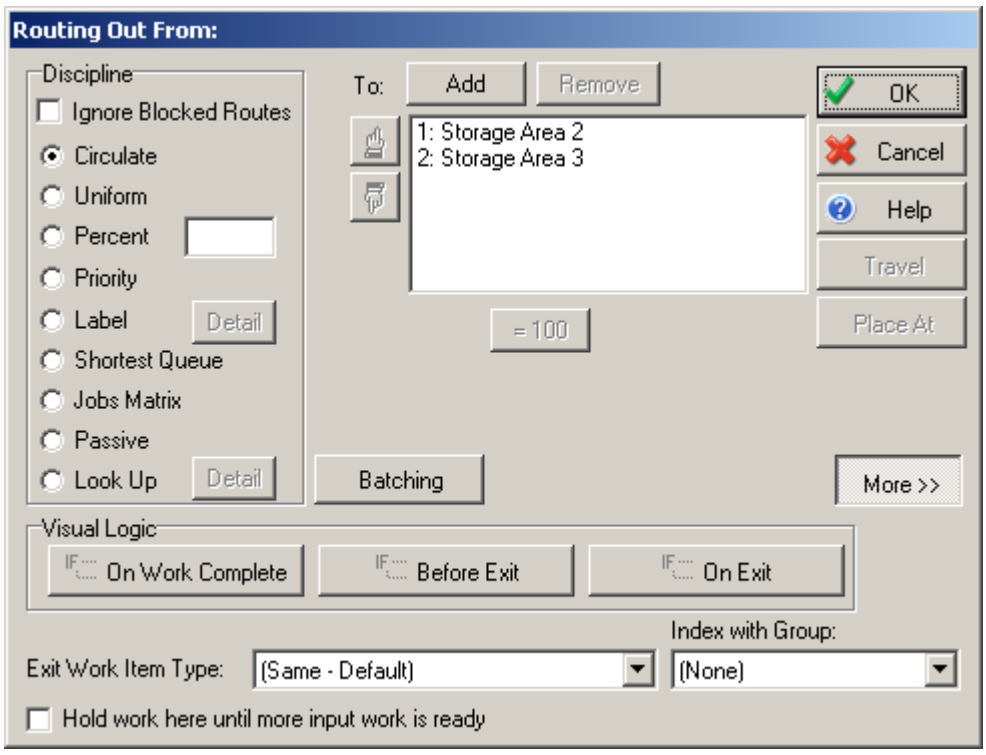
Here is an example of where you can place VL:



If you click this button you will go directly to a page where you can choose logic ("Visual Logic") to be obeyed by your simulation when this distribution is about to be sampled.

Once you have entered some VL here, clicking the button goes straight back to the same logic so you can easily see exactly what logic is used at a particular place.

Here are some more examples of where you can access VL:



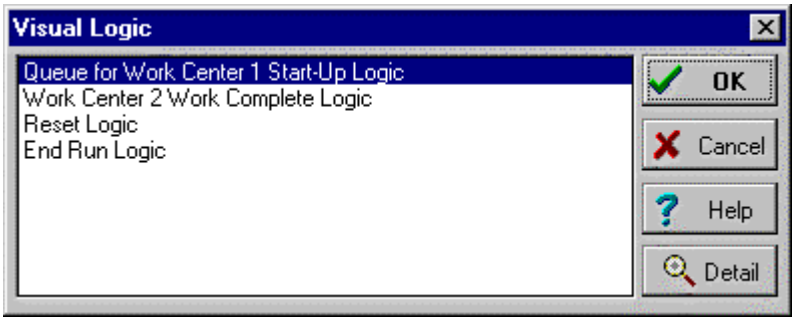
When a work item completes work in a work center, the "On Work Compete" logic can be obeyed.

There are many places where you can access VL directly from the relevant place in your model:

On Work Complete
Before Exit
On Exit Work Center
On Action (in Work Centers)

On Action (in Work Entry Points)
On Route In (before selecting a work item)
On Route In (after selecting a work item)
On Action (in Storage Bin initialization)
On Reset
On EndRun
On Start Run
On Stop Run (when the stop button clicked but not at the end of a run)
On End Trial (at the end of multiple runs)
On Time Check (at any time you decide)

You can also access any VL code directly from the Visual Logic Dialog (Choose Tools / Visual Logic):



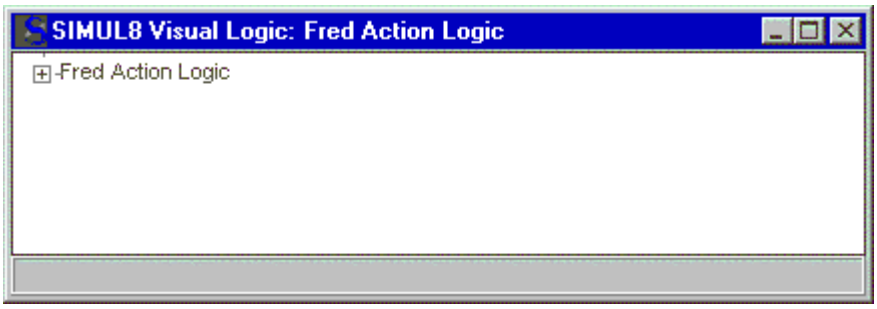
The structure of Visual Logic Itself.

VL is different from most code you will have seen before.

Most VL is not typed. It is chosen from menus - but menus which are structured to make the choosing much faster than typing - and much easier than remembering what to type.

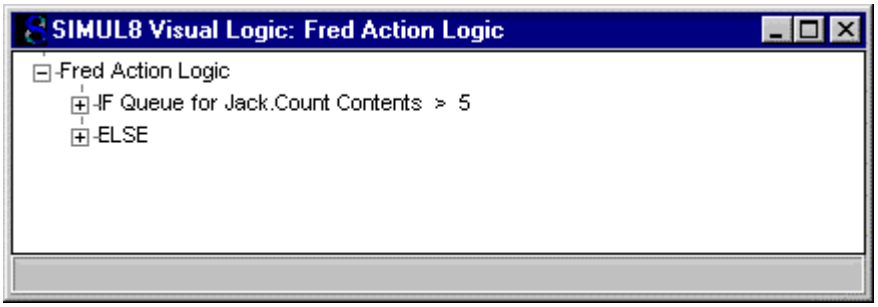
It is also hierarchical - so even large amounts of VL can be reviewed and understood quickly.

Here is a very small example.(This example is based on VLDEMO2.S8 in the examples directory):



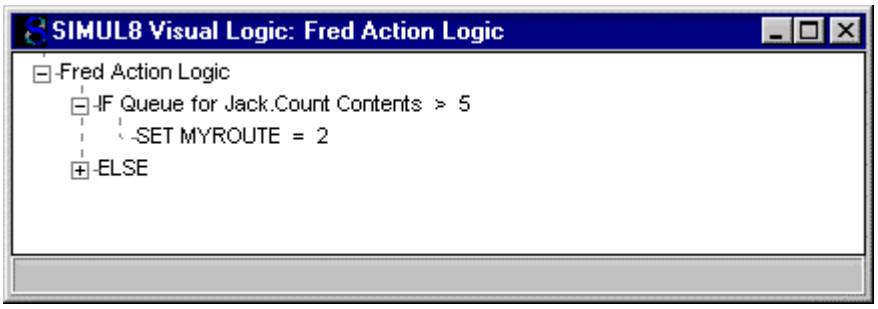
The "+" next to "Fred Action Logic" means there is some VL inside the structured block called "Fred Action Logic". This is the logic to be obeyed when Fred finishes work on an work item.

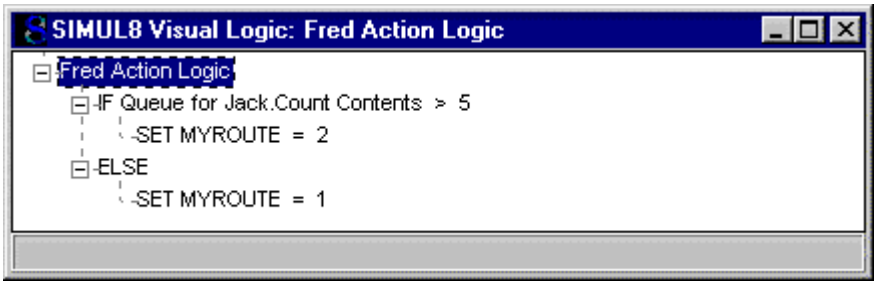
Click on the "+"



Here are two additional blocks. The contents of the first to be obeyed if the queue for Jack contains more than 5 work items.

You can open and close any block or sub block to make reading of VL convenient and organized.




SIMUL8 Visual Logic: Fred Action Logic
Fred Action Logic
IF Queue for Jack.Count Contents > 5
SET MYROUTE = 2
ELSE
SET MYROUTE = 1

In this VL the label MYROUTE is set to 1 or 2 depending on the size of the queue for Jack.

You may have as many levels in the hierarchy as you need and as many lines within any block as you need. There are no limitations.

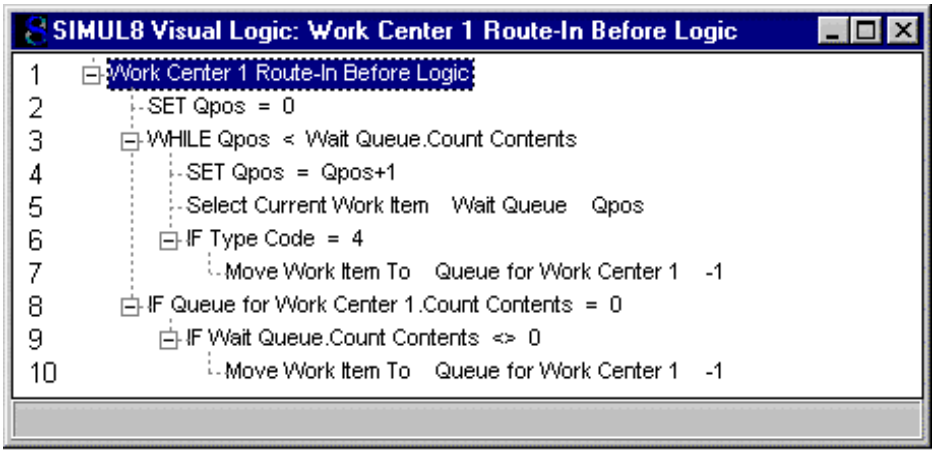
Visual Logic Basics

What happens when **SIMUL8** obeys some VL? The answer is similar to other scripting languages (like Visual Basic, for example) but with a few keys points which help you in the context of simulations.

VL Blocks

VL code is blocked in a hierarchy. Each line has a parent line and may have a number of siblings. A VL block is a group of siblings which all belong to one parent. You have already seen that you can hide all the children of a parent by clicking the "-" next to the parent line. The visibility of the block in the VL window has no affect of whether a block is obeyed. A block is obeyed whenever its parent is obeyed and the parent line tells the child block to be obeyed.

This sounds complicated but it is not. Example:


SIMUL8 Visual Logic: Work Center 1 Route-In Before Logic
1 Work Center 1 Route-In Before Logic
2 SET Qpos = 0
3 WHILE Qpos < Wait Queue.Count Contents
4 SET Qpos = Qpos+1
5 Select Current Work Item Wait Queue Qpos
6 IF Type Code = 4
7 Move Work Item To Queue for Work Center 1 -1
8 IF Queue for Work Center 1.Count Contents = 0
9 IF Wait Queue.Count Contents <> 0
10 Move Work Item To Queue for Work Center 1 -1

(in this example we have numbered the lines to make it easier to explain).

Lines 2, 3 and 8 are all siblings. They are one block. They have one parent (Line 1) and will all be obeyed if line 1 is obeyed.

Line 3 and 8 also have children of their own.

When Line 3 is obeyed it tells its children to be obeyed if "Qpos" is less than the number of work items in the queue called Wait Queue.

Because Line 3 is a "WHILE" it will repeatedly tell its children to be obeyed unless the condition fails. (Notice that one of the child lines (Line 4) increments Qpos - so eventually Qpos will exceed the limit tested in Line 3 and the children of line 3 will not long be obeyed. **SIMUL8** then jumps to line 8.

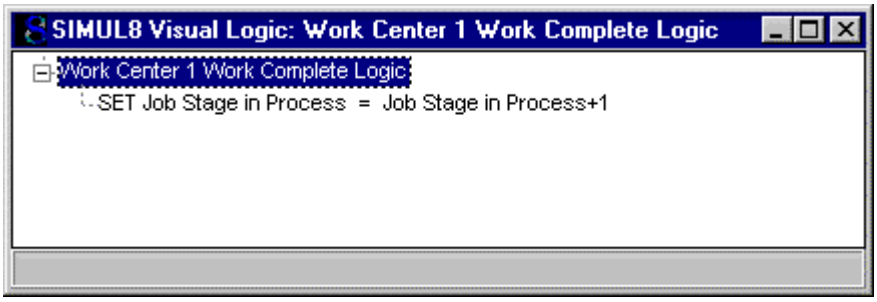
Similarly Line 7 will only be obeyed if the condition in Line 6 is OK and so on.

Current Work Item

The "Current Work Item" is a very useful concept which lets you quickly do many things with one individual work item.

For example, during the VL code inside the "On Work Complete" button the "Current Work Item" is the work item which has just finished work. So, if you set a label you will be setting a label on the current work item.

Here's an example:


SIMUL8 Visual Logic: Work Center 1 Work Complete Logic
Work Center 1 Work Complete Logic
SET Job Stage in Process = Job Stage in Process+1

The label called "Job Stage in Process" is incremented so that the work item knows how many times it has been through this work center. Every work item will have this label, but each of them may contain different values.

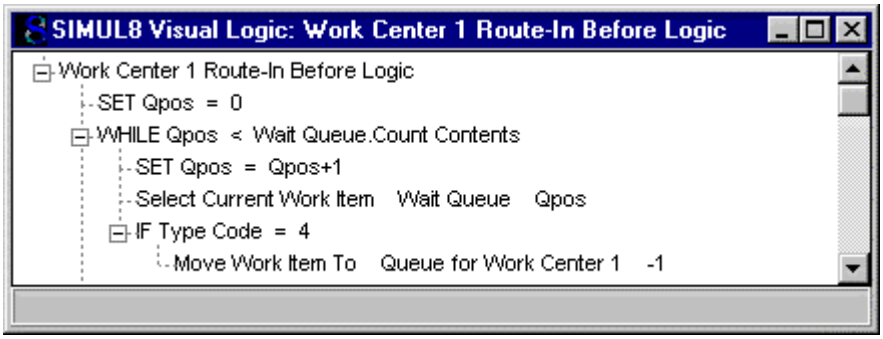
The "Current Work Item" is almost always the work item you are dealing with in your VL code. If a operation does not mention which work item to use then it is the "current work item" which will be used.

"Delete Work Item", will, for example, remove the "Current Work Item" from the simulation object which currently holds it and completely remove it from the simulation.

In some sections of VL there is no current work item. For example "On Route In Before". VL code inside this button is obeyed when an empty work center is about to select a work item to draw into the work center. This means that there is no work item in the work center and many potential work items might be selected. Hence there is no current work item at this stage.

You can select a current work item. Do this in some code which does not normally have a current work item (as just discussed), or when you want to deal with a different work item (different from the one which **SIMUL8** made the current work item at the start of the section of VL code).

Example: In this VL we are looking for work which has a label "Type Code" set to 4. (When we find it we move it to a particular queue).


SIMUL8 Visual Logic: Work Center 1 Route-In Before Logic
Work Center 1 Route-In Before Logic
SET Qpos = 0
WHILE Qpos < Wait Queue.Count Contents
SET Qpos = Qpos+1
Select Current Work Item Wait Queue Qpos
IF Type Code = 4
Move Work Item To Queue for Work Center 1 -1

Above: The "WHILE" block checks every work item in the "Wait Queue" for a 4 in its Type Code label. Note that the "IF Type Code…." Line does not mention a particular work item. Instead the work item is the "Current Work Item" and this has been "selected" in the previous line.

Some facilities in VL automatically select a new current work item. For example "Add Work Item to Queue" creates a new work item and adds it to a queue. The created work item is then the current work item.

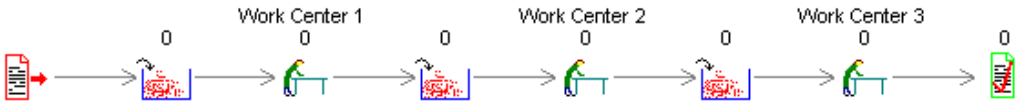
In those sections of VL which automatically provide a current work item, the Current Work Item supplied by **SIMUL8** is only accessible until you change it (using one of the facilities which selects a different work item as current).

Building Visual Logic

This section explains how to build VL code. It gives detailed instructions about how to input and edit VL.

We are going to build a simulation in which a standard facility is supplemented by a back up facility at busy times.

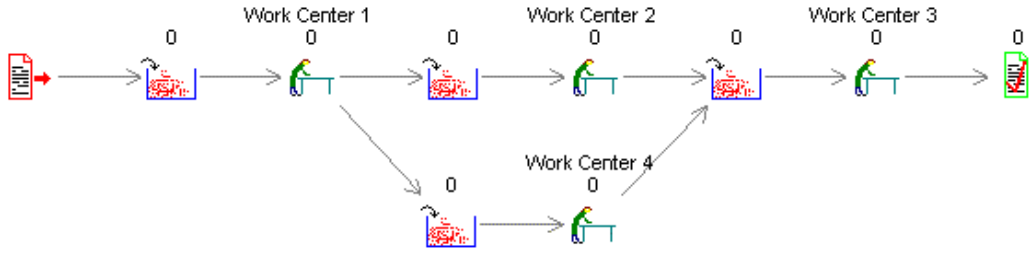
Create a simple model like this:



and change the processing time at Work Center 2 to 11 minutes.

Work Center 3 is very expensive so we want to make sure it is highly utilized so we are going to supplement work center 2 with a additional help but we will only use this when it would be useful to do so.

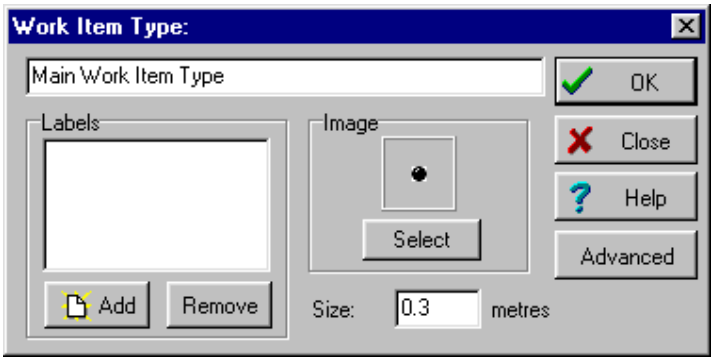
Copy work center 2 and its storage bin (drag a box around the bin and the work center, then drag the box while holding down the control key on the keyboard).



We are going to send work to work center 4 from work center 1 when there is not much work waiting at the important work center (3) but only if work center 2 is getting a behind with its work (there is a queue of work at it).

Specifically, if there are less than 3 items waiting for work center 3, and there is a queue at work center 2, then we will send work to work center 4 instead of 2.

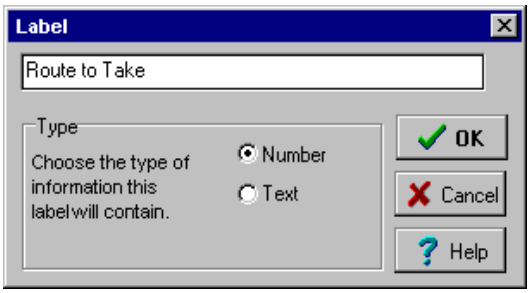
Go to Objects / Work Item Types for the Main Work Item Type.



Add a label to these work items (and call it "Route to take") - we are going to use "Label Routing" out of work center 1.

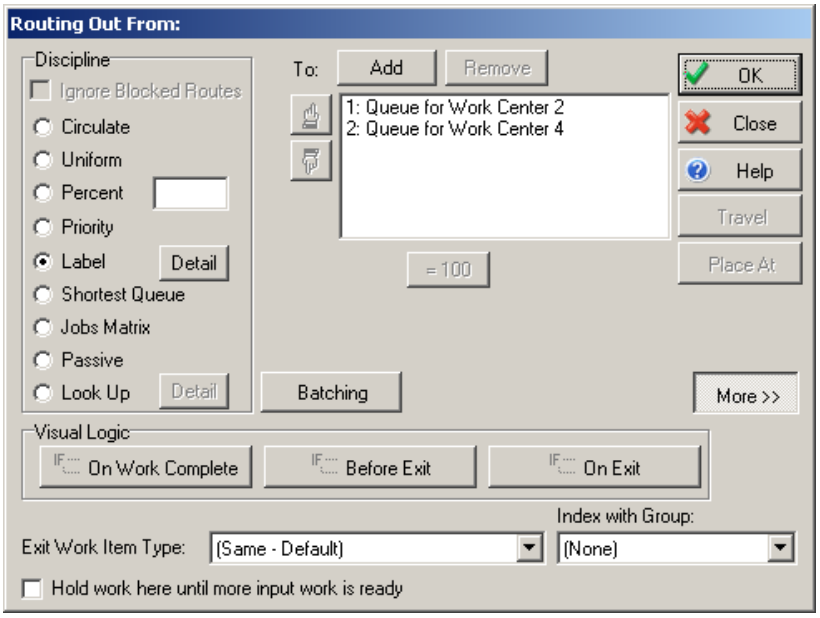
In the above dialog click ADD:

Then click NEW to create a new label and type in its name:



Click OK several times to get back to the main screen.

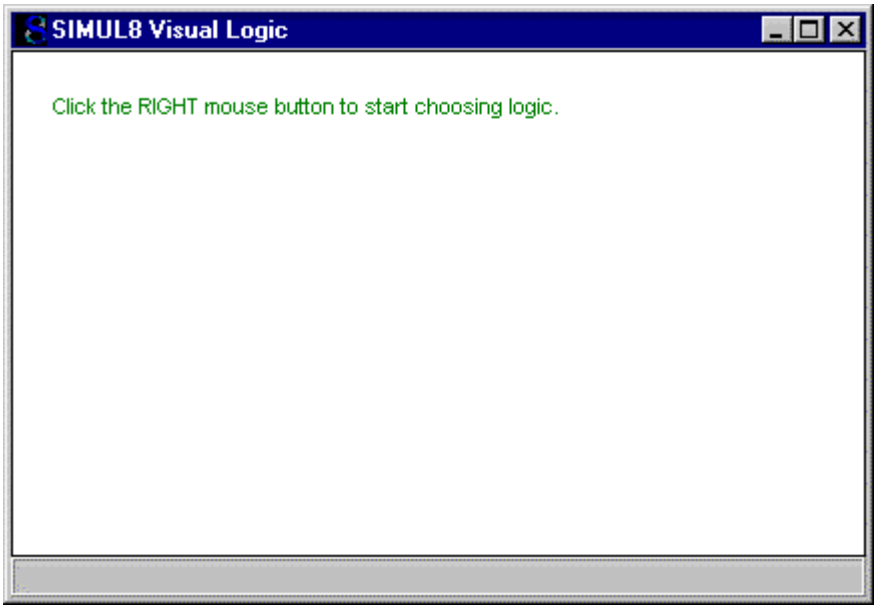
Click on work center 1 and change its routing out to "Label" and set the required label to "Route to take" in the DETAIL button.



Now we have to add the VL code to set the label to either: 1 (go to the first destination in the above list) or 2 (go to the second destination in the above list).

Click the On Work Complete button.

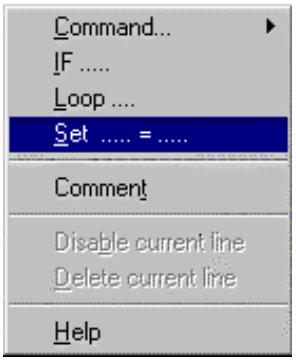
Now we have a blank window into which we can enter VL. This VL will be obeyed whenever a work item finishes its work at work center 1.

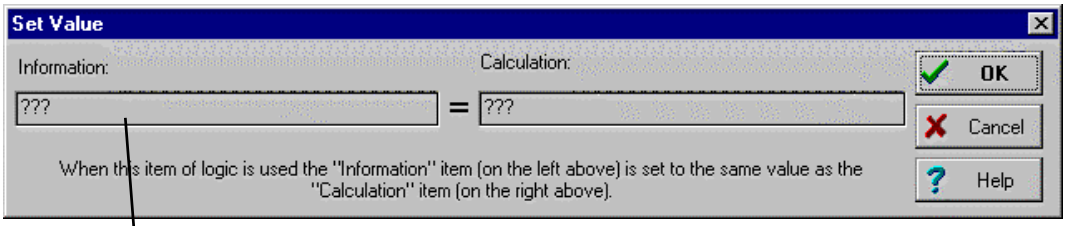


As the window says, click the RIGHT mouse button (in the window) to start adding logic.

The first thing to do is set the label to the default value (1 = go to Queue for Work Center 2).

Choose SET… from the menu when you click RIGHT.



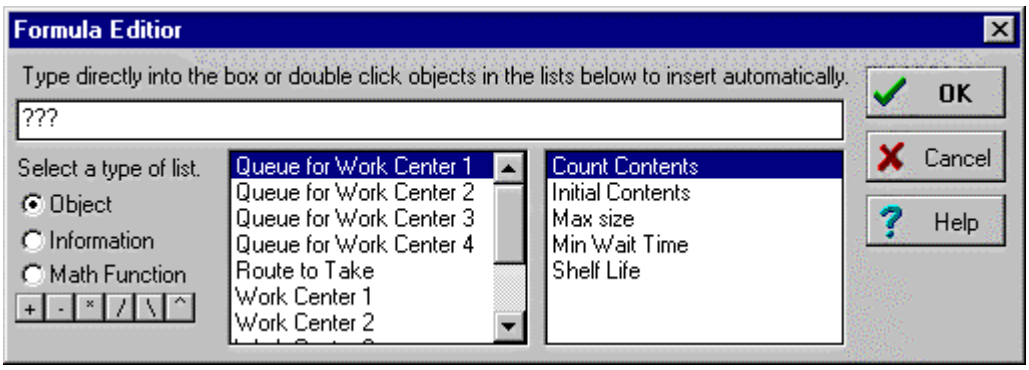


The SET VALUE dialog appears. You can set labels, global data (variables) and other changeable data here.

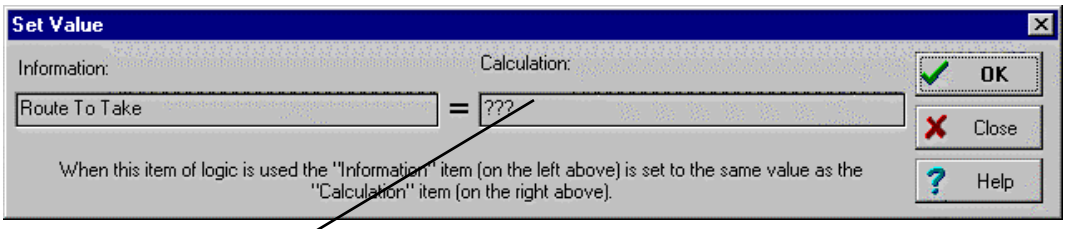
Click the left hand side box.

The formulae editor appears:

(make sure the OBJECT check box is checked)

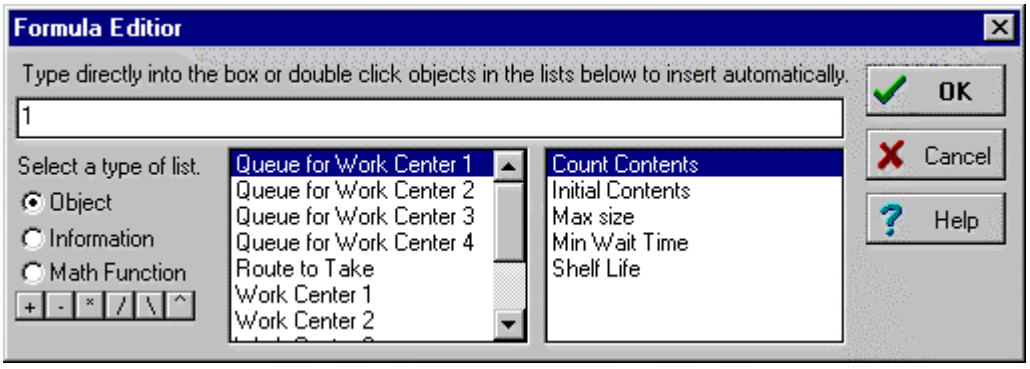


We want to set ROUTE TO TAKE - so double click it and then click OK.


Set Value
Information:
Calculation:
Route To Take
=
???
OK
Close
Help
When this item of logic is used the "Information" item (on the left above) is set to the same value as the "Calculation" item (on the right above).

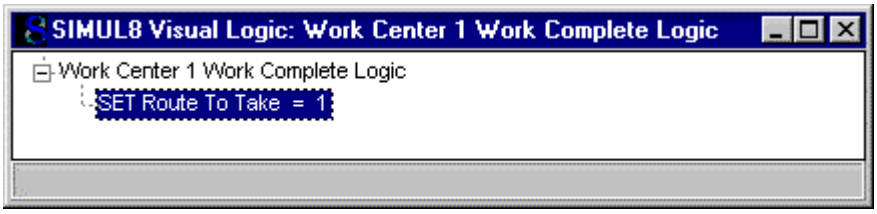
Now click the right hand side of the SET dialog.

We are now back in the formula editor but this time we want a value:



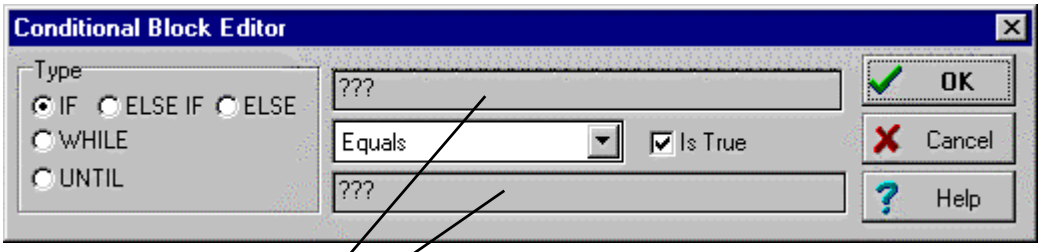
Just type a 1 into the box and click OK.

Click OK in the SET DIALOG too.



If you run the model with just this VL code it will behave as it did without Work center 4 because the label will always be 1 (= go to destination 1).

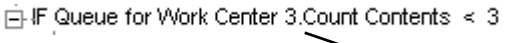
Click the right mouse button again (in the VL code window) and add an IF line. The Conditional Block Editor will appear.



(The Conditional Block Editor is also used to While and UNTIL blocks).

When you click either of the formula boxes you will see the formula editor again.

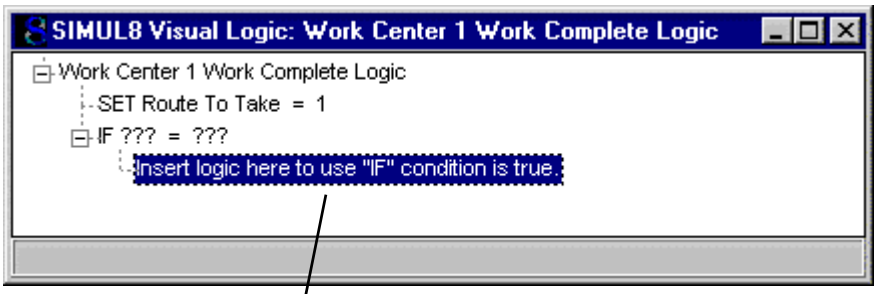
You want a line which looks like this:



so, click the top box and use the formula editor to select OBJECT. Then double click QUEUE FOR WORK CENTER 3 and then COUNT CONTENTS.

You will see that the formulae editor knows to insert a dot for you between the name of the object and the name of its property.

Use the formula editor to put a 3 in the bottom box and choose IS LESS THAN for the type of condition.

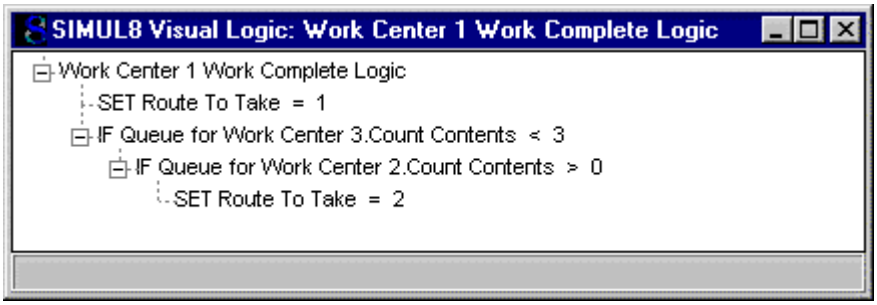


All VL lines which can have child lines automatically insert a dummy line when they have no children.

If you click RIGHT when a line is highlighted new lines are inserted at the same level in the hierarchy.

If you wanted to add a line at the same level as the SET and the IF lines (to be obeyed after the IF block) you would highlight (click on) the IF line first, then RIGHT click.

Add another IF inside the block for the first IF and then add another SET so you have some logic like this:

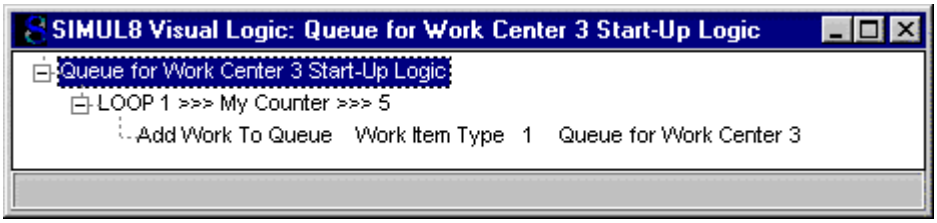


Running the model like this will increase the utilization of Work Center 3.

So far we have only looked at SET and IF lines.

Loop lines are important because they let you perform operations a specific number of multiple times.

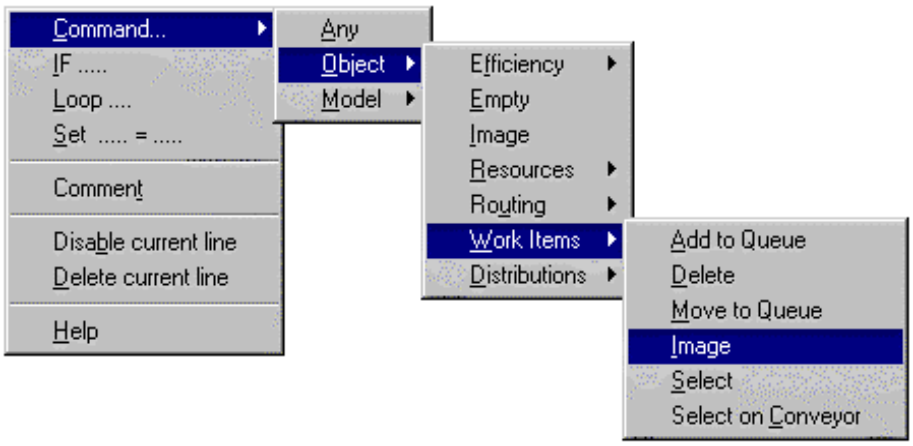
Loops require a "Global Data Item" to be used to count to number of times the loop is performed. (Create a Global Data Item in Objects / Information Store - make sure the item you create can contain NUMBERS).


SIMUL8 Visual Logic: Queue for Work Center 3 Start-Up Logic
Queue for Work Center 3 Start-Up Logic
LOOP 1 >>> My Counter >>> 5
Add Work To Queue Work Item Type 1 Queue for Work Center 3

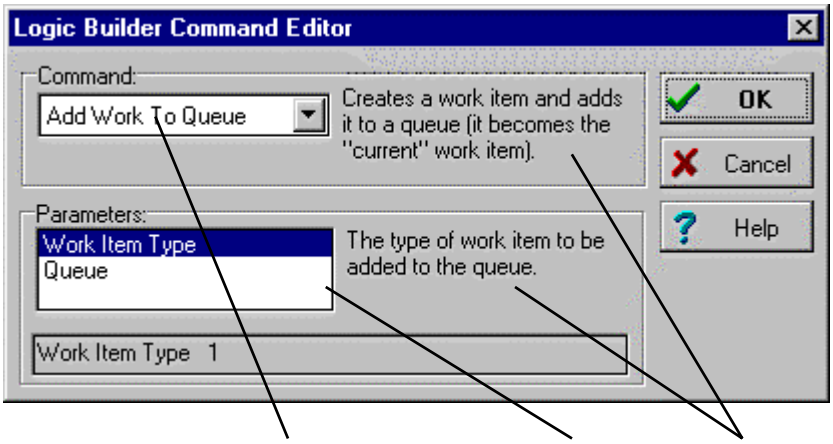
This loop is used to add 5 work items to the queue for Work Center 5 when the model is reset.

What type of line is "Add Work Item to Queue"?

This is a "Command". Commands are not part of the structure of VL. They are specific to the requirements of **SIMUL8**. There are many commands - explore the menus and see the section of this manual which lists them (page 260).



You can also explore the commands available from within the command editor. The command editor lets you easily enter parameters for each command.

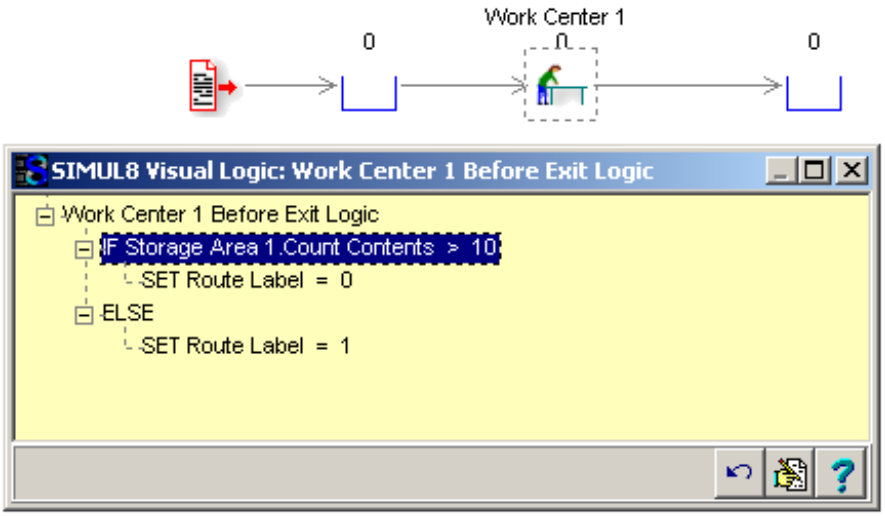

Logic Builder Command Editor
Command:
Add Work To Queue
Creates a work item and adds it to a queue (it becomes the "current" work item).
OK
Cancel
Help
Parameters:
Work Item Type
Queue
The type of work item to be added to the queue.
Work Item Type 1

As you change the command or click on parameters the text automatically changes to prompt you for the type of information required.

Before Exit Visual Logic and Label Based Routing

Before Exit Visual Logic is a special case of Visual Logic that allows control over a work center when its route out is blocked. Before Exit VL runs whenever an item leaves a Work Center, and also when the route out is blocked. The Before Exit VL then will run continuously until a valid exit route is available.

Additionally, before Exit VL is designed to work with Label Based routing where the Label used for Routing has a value 0.

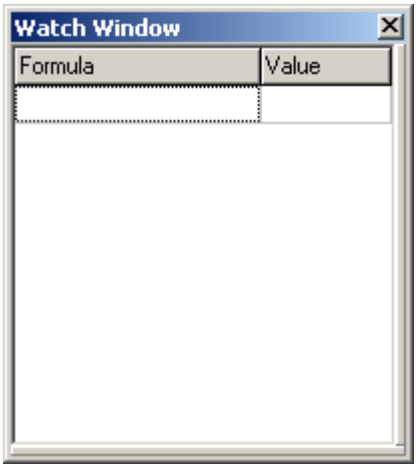

Work Center 1
0
0
SIMUL8 Visual Logic: Work Center 1 Before Exit Logic
Work Center 1 Before Exit Logic
IF Storage Area 1.Count Contents > 10
SET Route Label = 0
ELSE
SET Route Label = 1

In this example the Label value is set to 0 when the number of items in a store reaches 10. When the value is less than 10 then the Label is assigned value 1 and the item is allowed to continue to the store.

Watch Window

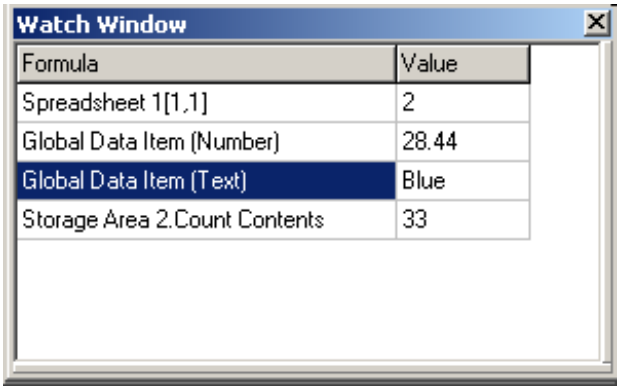
The Watch Window allows key pieces of information to be placed into a central location, allowing easy viewing of key results.

Select the Tools menu, Watch Window option and the Watch Window will be displayed.



Double Click or Right Click and select Add in the Watch Window to add an entry. This will access the Formula Editor and you can then select any Global Data Item from the Information Store or parameter of an Object listed in the Object list.

Any item created in the Information Store can be added to the Watch Window, by Right Clicking on the Global Data Item in the Information Store.



The above example shows a range of item types that can be added to the Watch Window.

Using Simulation Object Global Data Items

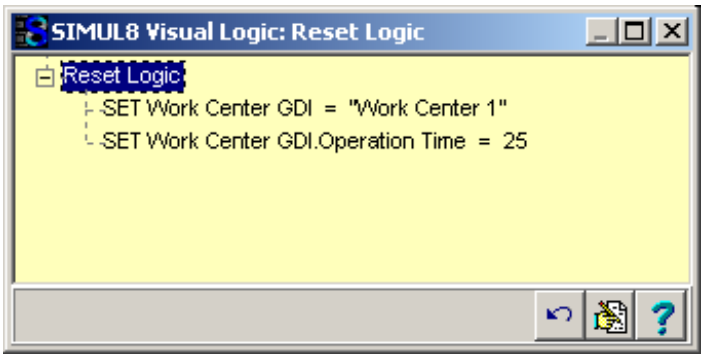
Variables in the **SIMUL8** information store can contain references to simulation objects. This makes Visual Logic very powerful because it can perform the same task on many simulation objects.

With a global data item for Storage Bins set up in the Information Store (called VAR1) and also a simple "number" global data item (NUM) you can write Visual Logic like this:

Loop 1 >>> NUM >>> 10
    VAR1 = "Queue for Work Center" + NUM
    VAR1.Max Size = 50

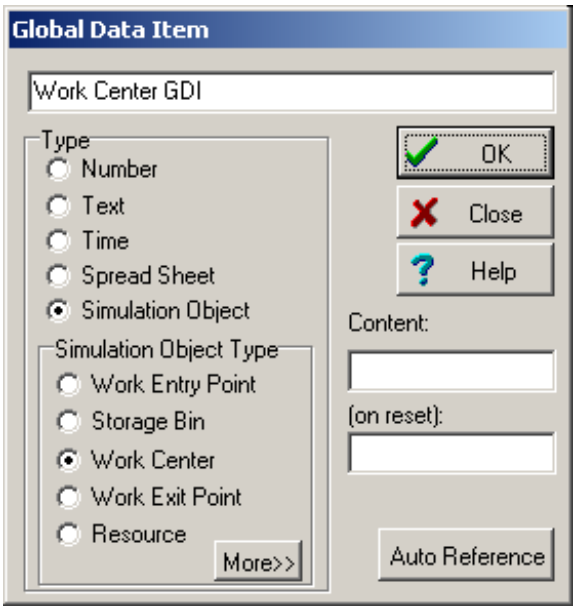
AutoReference Global Data Items

When an Object Global Data Item is created it must normally be manually set to refer to an Object that exists in the simulation. For example:

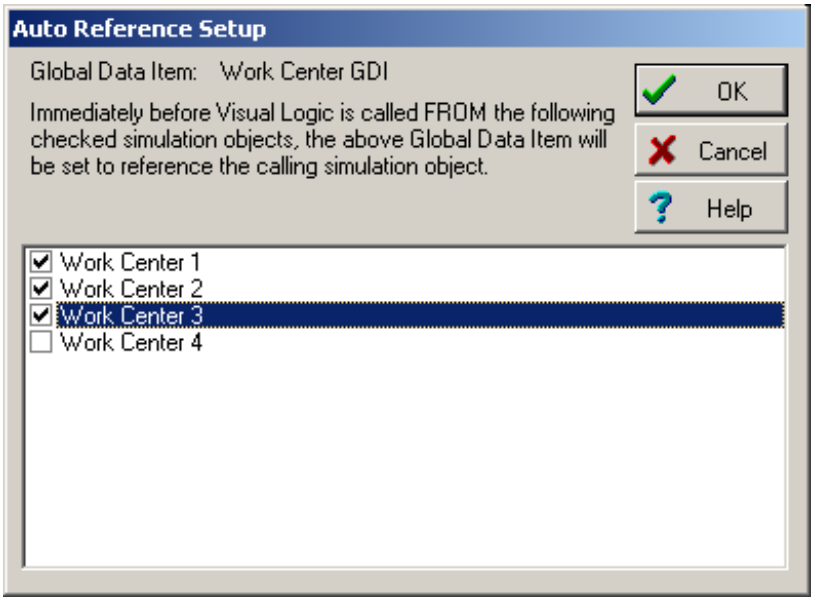


This code sets the Object Global Data Item called "Work Center GDI" to be Work Center 1, and then allows changes to be made to Work Center 1's properties.

The AutoReference function is located in the Global Data Item properties dialog (use the Objects, Information Store menu option and create a New Global Data Item. Select Simulation Object to create this as an Object Global Data Item.



The AutoReference button produces a new Dialog:


Auto Reference Setup
Global Data Item: Work Center GDI
Immediately before Visual Logic is called FROM the following checked simulation objects, the above Global Data Item will be set to reference the calling simulation object.
OK
Cancel
Help
Work Center 1
Work Center 2
Work Center 3
Work Center 4

This function sets the Object Global Data Item to contain the name of the Object that calls it, so when called by Work Center 1 the "Work Center GDI" becomes Work Center 1 without being set manually.

This is very powerful as it allows a single piece of Visual Logic to be written and the Called from within a set of work centers, allowing a piece of VL to be written and edited in a single place.

Editing Visual Logic

Visual Logic is very easy to change. Just double click a line to return to the dialog that created it and make any changes you require.

Lines can be dragged around to move them. Hold down the CONTROL key while dragging a line to copy it instead of just moving it.

Non-checked Edit Mode

The Visual Logic editor is designed to free you from needing to remember syntax. The menus guide you though every step in creating Visual Logic.

Some people prefer to type the logic directly. This is also possible but not recommend unless you are very familiar with Visual Logic syntax. Click the NON-CHECKED EDIT MODE button in the Visual Logic Editor.
Click it again to return to the checked mode. If the text you typed does not match **SIMUL8**'s requirements for Visual Logic, your text will be ignored.

Copying Visual Logic

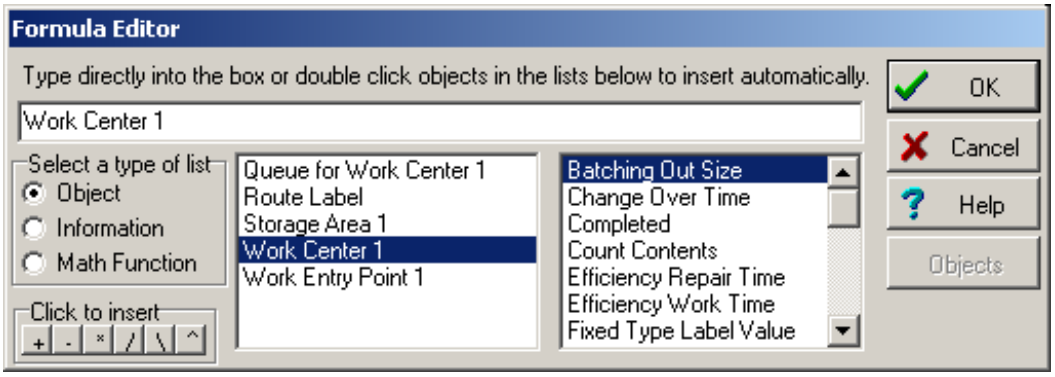
In addition to copying Visual Logic by holding down the control key while dragging, lines can be copied/pasted to/from the windows clipboard and then into other blocks of Visual Logic (even in other simulations). If you copy some Visual Logic that refers to a simulation object that does not exist in the new context, **SIMUL8** will automatically adjust the names where possible.

When **SIMUL8** objects are copied on the simulation window, Visual Logic inside those objects is automatically copied and names are adjusted to match the newly created objects.

Object Properties

Each Object in a simulation has a number of properties, for example Name, number of Work Items currently in the object, the routing discipline used and so on.

Each of these properties can be controlled through Visual Logic. The Object Properties can be altered by using the Set Value Editor:



When an object is selected in the left hand panel its properties will become available in the right hand panel.

Certain items listed in the left hand panel will have no properties or properties that should be set elsewhere. Labels have no editable property (they can only be set to a number or text) and Distributions should be amended using the Distribution menu option from the Visual Logic menu.

Conveyor Visual Logic Properties

The Conveyor properties that are editable through the Visual Logic Set Value editor are:

Allow Gaps: toggles on and off the Allow Gaps check box.
Example: Set Conveyor1.Allow Gaps = 1: checks the box.
Set Conveyor1.Allow Gaps = 0: un-checks the box.

Efficiency Repair Time: Sets the Repair time in Detailed Efficiency to a fixed value
Example: Set Conveyor1.Efficiency Repair Time = 5 (can also be a Global Data Item or Distribution)

Efficiency Work Time: Sets the Time Between Breakdowns in Detail Efficiency to a fixed value
Example: Set Conveyor1.Efficiency Work Time = 100 (can also be a Global Data Item or Distribution)

Ignore Blocked Routes: Sets the Conveyor's Routing Out Property check box for. Ignore Blocked Routes to either Checked or not Checked.
Example: Set Conveyor1.Ignore Blocked Routes = 1: checks the box
Set Conveyor1.Ignore Blocked Routes = 0: un-checks the box

Image: sets the image used for the conveyor to any image located in the Graphics, Images menu option.
Example: Set Conveyor1.Image = "BlueB": where BlueB exists as an image. Note the Inverted Commas around the name of the image

Index: Sets the Index number of the Conveyor to a value other than the default value.
Example: Set Conveyor1.Index = 5

Length: Changes the length of the conveyor. The length will be in Distance Units (see Tools menu, Preferences, Distance option). This replaces any length parameter that has been set in the Conveyor Dialog.
Example: Set Conveyor1.Length = 25: changes the length of the conveyor to 25 units.

See Also Length Label

Load Space: used with the Transport Plug-In to amend the side of conveyor space allocated to loading items
Example: Set Conveyor1.Load Space = 5: sets the Load Space to 5 units

Name: allows the name of the Conveyor to be changed or accessed.
Example: Set Conveyor1.Name = "Change the Name": changes the name to whatever is inside the inverted commas
Set Var1 = Conveyor1.Name: sets a text Global Data Item to contain the name of the conveyor

Speed: sets the Speed that the conveyor runs at to a value. This replaces any speed parameter that has been set in the Conveyor Dialog.
Example: Set Conveyor1.Speed = 10

Conveyor Properties that return results are:

Count Contents: returns the number of work items currently located on the conveyor.
Example: Set Var1 = Conveyor1.Count Contents

In Count: Returns the number of incoming routes to the Conveyor.

Example: Set Var1 = Conveyor1.In Count: Sets Var1 to the number routes that are connected to the Conveyor

Out Count: Returns the number of Outgoing routes from the Conveyor.
Example: Set Var1 = Conveyor1.Out Count: Sets Var1 to the number routes that are connected from the Conveyor

Ready Time: Returns the number of time units from now that an item is likely to reach the head of the conveyor ("likely" because numberous things that could alter this value may occur; breakdowns, blockages etc.).
Example: Set Var1 = Conveyor1.Ready Time

State: the State property returns the current working state of the conveyor
Example: Set Var1 = Conveyor1.State

Unique ID: Gets SIMUL8's internal Unique Number that identifies every object - you can be sure it is different for all objects. It never changes once an object is in a model

Resource Visual Logic Properties

The Resource properties that are editable through the Visual Logic Set Value editor are:

Current Available: allows the number of Resources available to be set
Example: Set Resource1.Current Available = 5: limits the number of Resources available to 5

Image: sets the image used for the Resource to any image located in the Graphics, Images menu option.

Example: Set Resource1.Image = "BlueB": where BlueB exists as an image. Note the Inverted Commas around the name of the image

Index: Sets the Index number of the Resource to a value other than the default value.
Example: Set Resource1.Index = 5

Max Available: Sets the Maximum Number of Resources available to a number. It is generally better to use this command to set the number of resources available at any time.
Example: Set Resource1.Max Available = 5

Name: allows the name of the Resource to be changed or accessed.
Example: Set Resource1.Name = "Change the Name": changes the name to whatever is inside the inverted commas
Set Var1 = Resource1.Name: sets a text Global Data Item to contain the name of the Resource

Resource Properties that return results are:

Current Available: Returns the number of Resources not currently in use.
Example: Set Var1 = Resource1.Current Available: this sets Var1 to contain the number of free resources

In Count: Not used with Resources – returns 0

Out Count: Not used with Resources – returns 0

Unique ID: Gets SIMUL8's internal Unique Number that identifies every object - you can be sure it is different for all objects. It never changes once an object is in a model

Storage Area Visual Logic Properties

The Storage Area properties that are editable through the Visual Logic Set Value editor are:

Image: Sets the image used for the Storage Area to any image located in the Graphics, Images menu option.
Example: Set Storage Area1.Image = "BlueB": where BlueB exists as an image. Note the Inverted Commas around the name of the image

Index: Sets the Index number of the Storage Area to a value other than the default value.
Example: Set Storage Area1.Index = 5

Initial Contents: sets the Start Up contents of the Storage Bin.
Example: Set Storage Area1.Initial Contents = 10: places 10 items into the store at the start of each run

Max Size: Sets the Capacity of the Storage Area
Example: Set Storage Area1.Max Size = 10: sets the capacity of the store to 10.

Min Wait Time: Sets the Minimum Wait Time property.
Set Storage Area1 = 5: each item will wait 5 minutes before being released from the Storage Area.

Name: allows the name of the Storage Area to be changed or accessed.
Example: Set Storage Area1.Name = "Change the Name": changes the name to whatever is inside the inverted commas

Set Var1 = Storage Area1.Name: sets a text Global Data Item to contain the name of the Storage Area

Shelf Life: Sets the Shelf Life of the Storage Area.
Example: Set Storage Area1.Shelf Life = 5: sets the maximum amount of time each item can remain in the Storage Area. Use this with an Expired Only Work Center.

Travel and Contents: Returns the number of items currently in and on their way to the store. This include any item travelling on a transit link to the store and items currently in the store.
Example: Set Var1 = Storage Area1.Travel and Contents.

Storage Area Properties that return results are:

Count Contents: returns the number of work items currently located on the Storage Area.
Example: Set Var1 = Storage Area1.Count Contents

In Count: Returns the number of incoming routes to the Storage Area.
Example: Set Var1 = Storage Area1.In Count: Sets Var1 to the number routes that are connected to the Storage Area

Out Count: Returns the number of Outgoing routes from the Storage Area.
Example: Set Var1 = Storage Area.Out Count: Sets Var1 to the number routes that are connected from the Storage Area

Unique ID: Gets SIMUL8's internal Unique Number that identifies every object - you can be sure it is different for all objects. It never changes once an object is in a model

Work Centers Visual Logic Properties

The Work Center **properties** that are editable through the Visual Logic Set Value editor are:

Batching Out Size: Changes the fixed value in the Batching Distribution.
Example: Set WorkCenter1.Batching Out Size = 10: sets the value used in Routing Out, Batching to 10

Change Over Time: sets the fixed value used in the Change Over Distribution.
Example: Set WorkCenter1.Change Over Time = 5: changes the chage over time to 5.

Efficiency Repair Time: Sets the Repair time in Detailed Efficiency to a fixed value
Example: Set WorkCenter1.Efficiency Repair Time = 5 (can also be a Global Data Item or Distribution)

Efficiency Work Time: Sets the Time Between Breakdowns in Detail Efficiency to a fixed value
Example: Set WorkCenter1.Efficiency Work Time = 100 (can also be a Global Data Item or Distribution)

Fixed Type Label Value: used with Batch By Type to set or change the fixed Label value used to source items.
Example: Set WorkCenter1.Fixed Type Label Value = 4: the work center will only pull items with the value 4 in the lable nominated for use with Batch By Type.

Ignore Blocked Routes: Sets the Work Center Routing Out Property check box for. Ignore Blocked Routes to either Checked or not Checked.

Example: Set WorkCenter1.Ignore Blocked Routes = 1: checks the box
Set WorkCenter1.Ignore Blocked Routes = 0: un-checks the box

Ignore Starved Routes: Works with the Routing In option Circulate to only pull from routes that contain work items.
Example: Set WorkCenter1.Ignore Starved Routes = 1: checks the box so ignore starved routes and pull from the next route in the list
Set WorkCenter1.Ignore Starved Routes = 0: unchecks the box so wait for any starved routes until they contain a work item.

Image: sets the image used for the Work Center to any image located in the Graphics, Images menu option.
Example: Set WorkCenter1.Image = "BlueB": where BlueB exists as an image. Note the Inverted Commas around the name of the image

Index: Sets the Index number of the Work Center to a value other than the default value.
Example: Set WorkCenter1.Index = 5

Interrupt Store: Sets the name of the store used to contain Interrupted work items
Example: Set WorkCenter1.Interrupt Store = "Interrupt Queue": Note that the name of the store is in inverted commas. The store must exist in the simulation or the command will be ignored and Interruptible will be turned off. If Interruptible is turned off then setting the Interrupt Store to a valid store will turn it on.

Label Batching Max: Sets the Max value used with Label Batching.
Label Batching Min: Sets the Min value used with Label Batching.
Example: Set Work Center 1.Label Batching Max = 10
Set Work Center 1.Label Batching Min = 5
Together these work to set the maximum and minimum values used in Label Batching.

Locked In Route: Locks the Work Center to use the nominated Route only. This works from the position in the list of the Route, not the name of the source of the items.
Example: Set Work Center 1. Locked In Route = 2: this limites the work center to pull only from Route 2 (the route listed second in the Route In Properties). All other Routes will be ignored until the route is changed.

Name: allows the name of the Work Center to be changed or accessed.
Example: Set WorkCenter1.Name = "Change the Name": changes the name to whatever is inside the inverted commas
Set Var1 = WorkCenter1.Name: sets a text Global Data Item to contain the name of the WorkCenter1.

Operation Time: this changes the timing information used by the work center to a Fixed value.
Example: Set Work Center 1.Operation Time = 25: sets the cycle time to a Fixed value of 25.

Priority: Sets the Priority of the work center to a value.
Example: Set Work Center 1.Priority = 70. When there is a copmpetition for resources this work center will rank above any work center with a priority of les than 70, and below any work centers with a value more than 70.

Replication: Sets the effective number of work centers to a value.
Example: Set Work Center 1.Replication = 10: sets the replication value to 10

Work Center Properties that return **results** are:

Completed: returns the number of work items that have exited a work center.
Example: Set Var1 = WorkCenter1.Completed.

Count Contents: returns the number of work items currently located in the Work Center.
Example: Set Var1 = WorkCenter1.Count Contents

In Count: Returns the number of incoming routes to the Work Center.
Example: Set Var1 = WorkCenter1.In Count: Sets Var1 to the number routes that are connected to the Work Center

Out Count: Returns the number of Outgoing routes from the WorkCenter.
Example: Set Var1 = WorkCenter.Out Count: Sets Var1 to the number routes that are connected from the Work Center

State: the State property returns the current working state of the Work Center
Example: Set Var1 = WorkCenter1.State

Unique ID: Gets SIMUL8's internal Unique Number that identifies every object - you can be sure it is different for all objects. It never changes once an object is in a model

Work Complete Point Visual Logic Properties

The Work Complete Point **properties** that are editable through the Visual Logic Set Value editor are:

Halt Limit: Sets the Halt Limit property to a value.
Example: Set Work Complete Point1.Halt Limit = 1000: when 1000 items have entered the Work Complete Point the simulation will stop.

Image: sets the image used for the Work Complete Point to any image located in the Graphics, Images menu option.
Example: Set Work Work Complete Point1.Image = "BlueB": where BlueB exists as an image. Note the Inverted Commas around the name of the image

Index: Sets the Index number of the Work Complete Point to a value other than the default value.
Example: Set Work Complete Point1.Index = 5

Name: allows the name of the Work Complete Point to be changed or accessed.
Example: Set Work Complete Point1.Name = "Change the Name": changes the name to whatever is inside the inverted commas
Set Var1 = Work Complete Point1.Name: sets a text Global Data Item to contain the name of the Work Complete Pointt.

Work Complete Point Properties that return **results** are:

Count Contents: returns the number of items that have entered the Work Complete Point and hence exited the simulation.
Example: Set Var1 = Work Complete Point1.Count Contents

In Count: Returns the number of incoming routes to the Work Complete Point.
Example: Set Var1 = Work Complete1.In Count: Sets Var1 to the number routes that are connected to the Work Complete Point

Out Count: Not used with Work Complete Points – returns 0.

Lost Count: Returns the number of work items that have attempted entry but that were not able to enter.
Example: Set Var1 = Work Complete Point1.LostCount

Unique ID: Gets SIMUL8's internal Unique Number that identifies every object - you can be sure it is different for all objects. It never changes once an object is in a model

Work Entry Point Visual Logic Properties

The Work Entry Point **properties** that are editable through the Visual Logic Set Value editor are:

Batching Out Size: Changes the fixed value in the Batching Distribution.
Example: Set Work Entry Point1.Batching Out Size = 10: sets the value used in Routing Out, Batching to 10

First at Start: Sets the First at Start property to either checked or unchecked:
Example: Set Work Entry Point1.First at Start = 0: unchecks the property
Set Work Entry Point1.First at Start = 1: checks the property
When First at Start is checked than an item will enter the wokr entry point at time 0.

Ignore Lost: Turns off the warnign message whenever an item attempts to enter through the work entry point but is unable to.
Example: Set Work Entry Point1.Ignore Lost = 0: unchecks the property
Set Work Entry Point1.Ignore Lost = 1: checks the property
When checked the error message will appear

Image: sets the image used for the WorkCenter1 to any image located in the Graphics, Images menu option.
Example: Set Work Entry Point1.Image = "BlueB": where BlueB exists as an image. Note the Inverted Commas around the name of the image

Interarrival Time: Sets the Interarrival Time used in the Work Entry Point to a fixed value.
Example: Set Work Entry Point1.Interarrival Time = 20: sets the interarrival time to a fixed value of 20, so an item will arrive exactly every 20 minutes.

Index: Sets the Index number of the Work Entry Point to a value other than the default value.
Example: Set Work Entry Point1.Index = 5

Name: allows the name of the Work Entry Point to be changed or accessed.
Example: Set Work Entry Point1.Name = "Change the Name": changes the name to whatever is inside the inverted commas
Set Var1 = Work Entry Point1.Name: sets a text Global Data Item to contain the name of the Work Entry Point.

Operation Time: this changes the timing information used by the Work Entry Point to a Fixed value.
Example: Set Work Entry Point1.Operation Time = 25: sets the cycle time to a Fixed value of 25.

Unlimited: Sets the Unlimited property of the Work Entry Point.
Example: Set Work Entry Point1.Unlimited = 0: The check box is unticked
Set Work Entry Point1.Unlimited = 1: The check box is ticked
When Un-Ticked the Unlimited Check Box provides work items on demand, effectively recreating infinite supply of items. The Work Entry Point will not push items into the simulation in this case.

Work Entry Point Properties that return **results** are:

Arrived Count: returns the number of work items that have arrived through the Work Entry Point.
Example: Set Var1 = Work Entry Point1.Arrived Count: sets Var1 to contain the number of items that have entered through the work entry point. This includes any items that may have been lost.

Completed: returns the number of work items that have exited a Work Entry Point.
Example: Set Var1 = Work Entry Point1.Completed.

In Count: Not used with Work Entry Points – returns 0.

Out Count: Returns the number of Outgoing routes from the Work Entry Point.
Example: Set Var1 = Work Entry Point1.Out Count: Sets Var1 to the number routes that are connected from the Work Entry Point

Lost Count: Returns the number of work items that have attempted entry but that were not able to enter.
Example: Set Var1 = Work Entry Point1.LostCount

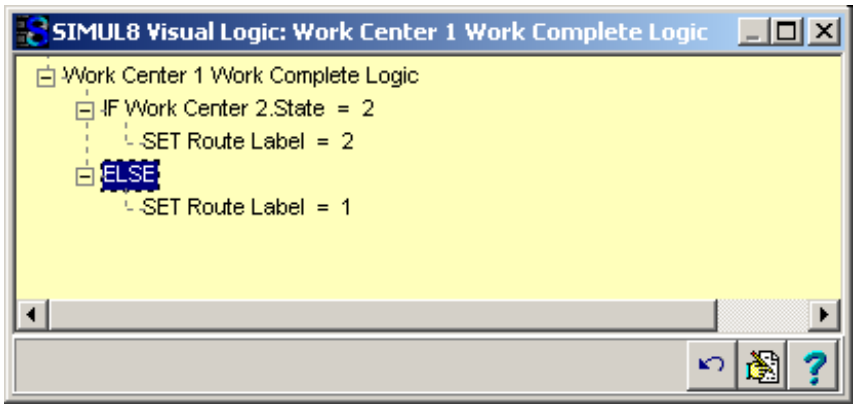
Unique ID: Gets SIMUL8's internal Unique Number that identifies every object - you can be sure it is different for all objects. It never changes once an object is in a model.

State Property

Every Active Object (objects that do work – eg work centers, conveyors) has a Current State. The State Property falls into 5 categories:

0: Waiting
1: Working
2: Blocked
3: Change Over
4: Stopped

Using Visual Logic you can query an object's state and use this to make decisions. For example, if a work center is broken down then change the route to send a work item along:


SIMUL8 Visual Logic: Work Center 1 Work Complete Logic
Work Center 1 Work Complete Logic
IF Work Center 2.State = 2
SET Route Label = 2
ELSE
SET Route Label = 1

In this case Work Center 1 uses Label Based Routing to route out to 2 destinations. By using the If... statement above Work Center 1 checks if Work Center 2 (a destination) is blocked and it then routes work items to a different destination.

Visual Logic Commands By Category

The next section gives all the VL commands and the details of their operation but lists them alphabetically. The current section categorizes the commands by type so it is easier to find the command you need for a particular purpose.

Model related commands

Reset	Resets the model to time zero
Run	Runs the model
Stop	Stops the model
Speed	Changes the speed of the model
Save	Saves the model to disk
VBA Signal	Sends a signal to Visual Basic (or EXCEL)
Beep	Sounds the PC bell
Delay	Stops for x seconds
Display Message	Stops and displays screen message
Break	Jumps out of an UNTIL, WHILE or LOOP

Object Related Commands

Work Items

Select	Selects a work item as the "current work item"
Select on Conveyor	Selects a work item by distance from front of conveyor.
Image	Changes the image used for the current work item

Add to Queue	Creates a new work item and adds it to a queue
Delete	Deletes the current work item from the model
Move	Moves the current work item to a new queue
Simulation Object	
Break Down	Stops a work center
Restart	Restarts a work center after Break Down
Empty	Deletes all work items in an object
Image	Changes the image for an object
Resources Required	Changes the number of a resource required at a work center
Set Collect	Changes the number of work items collected from a source during collect routing in
Set Route Out Discipline	Changes the method of routing out
Set Route Out Percent	For percentage routing out changes the percentage going to a particular destination
Percent Route Out Adjust to 100	Automatically pro-rata adjusts routing out %s so they add to 100
Distribution	
Probability Profile Column	Changes individual cells in user defined distributions
Named Distribution Parameters	Changes type of distribution (and shape)

Visual Logic Command Details

This section list alphabetically all the VL commands and explains their operation.

This information is also in the **SIMUL8** online help.

The convention used in this section is to name the command, then list the parameters used when selecting the command, and finally to provide an example of use.

Add Work Item to Queue command

Parameters

Work Item Type
Storage Bin

Description:

Creates a work item and adds it to the storage bin. The added work item becomes the Current Work Item.

VL SECTION: Example Block 1

```
Add Work To Queue    Main Work Item Type ,  Storage Area 1
SET Label 1  =  5
```

This block adds a work item to Storage Area 1 and then sets the value of Label 1 to 5. Add Work to Queue is a special case as there is no need to use the Select command to identify the Main Work Item.

Adjust Results Collection to Summary

Parameters

No parameters are required

Description:

Switches Results Collection on/off depending on use on Results Summary.

VL SECTION: Example Block 1

```
Adjust Results Collection to Summary
```

Generally used to optimize speed and memory use of SIMUL8. This command turns off Results Collection for every object in a simulation, except those that appear on the Results Summary.

Block Current Routing

Parameters

No parameters are required

Description:

Prevents the current routing activity

VL SECTION: Work Center 1 Route-In Before Logic
Block Current Routing

Use only inside "Route In Before" Visual Logic. Tells SIMUL8 that something is preventing work from entering this work center - something other than all the things that SIMUL8 considers. Normally this command will be used as part of an additional conditional statement, for example:

```
VL SECTION: Work Center 1 Route-In Before Logic
  IF Queue for Work Center 1.Count Contents > 5
    Block Current Routing
```

will prevent items entering the work center "Work Center 1" only when the queue contents exceed th elimit of 5, otherwise the command is not obeyed and the route is again available.

Beep

Parameters

No parameters are required

Description:
Sounds the PC bell

```
VL SECTION: Work Center 1 Route-In After Logic
 IF Queue for Work Center 1.Count Contents  >  5
  Beep
```

Useful for checking your logic - if the bell sounds then you know that piece of Visual Logic is being obeyed.

Break

Parameters
No parameters are required

Description:
Jumps out of a LOOP, UNTIL or WHILE and begins execution at the line after the loop.

```
VL SECTION: Work Center 1 Route-In After Logic
 LOOP 1 >>> token >>> 10
  Select Current Work Item    Queue for Work Center 1 ,  token
  IF Label 1  =  5
   Break
```

Useful when a loop is used to find a work item in a queue - break when you have found the item required. This example loops through store Queue for Work Center 1, selecting and examining the value of Label 1. If a work item with the value 5 is found then the Loop command is terminated.

BreakDown

Parameters

Simulation Object
(Conveyor, Work Center, Work Entry Point)
Duration

Description:
Stops a work center, Work Entry Point, or Conveyor for Duration time units. If Duration = 0 then Work Center will not automatically re-start.

Comment:
Use with Work Entry Points to stop arrivals

See also:
Break Restart

BreakRestart

Parameters:

Simulation Object
(Conveyor, Work Center, Work Entry Point)

Description:
Restarts a stopped (broken down) a work center (etc).

See also:
Break Down

This example shows Break Down and Break Restart working together.

VL SECTION: Example VL
IF Queue for Work Center 1.Count Contents > 10

```
  BreakDown    Work Entry Point 1 ,  0
ELSE
  BreakRestart    Work Entry Point 1
```

In this example items are prevented from entering the simulation when the volume in the store is more than 10 units.

Call COM Event

COM (Component Object Model) is a method of enabling communication between packages. COM is available only with SIMUL8 Professional or the COM plug-in

Definition:

Sends a string of text to a programming language, such as Microsoft Visual Basic, Microsoft Visual Basic for Applications, Borland Delphi, or any other COM enabled package

Description:

Enter the text, in inverted commas, that will call the COM event

Comment:

Use this command to invoke a COM event. For example at the end of a simulation run or trial it may be desirable to send a command to run or contine a routine

Clear Object Selection

Parameters

No parameters are required

Description:

Deselects all selected simulation objects

Used when Copying simulation objects through VL to clear the sleection and allow other objects to be selected independently.

See also:

Copy Selected Objects
Set Object Location

Copy Selected Objects

Parameters

X - Horizontal Offset for Copy
Y - Vertical Offset for Copy

Description:

Creates a copy of all selected simulation objects.

Normally used in conjunction with a Dialog box to allow a user to make alteration to the number of objects on the screen

See also:

Select Simulation Object
Clear Object Selection

Clear Sheet

Definition:

Clears a SIMUL8 spreadsheet, deleting all data and any formatting features, graphs, buttons or other features.

Description:

Specify the name of the spreadsheet. set the Column and Row parameters to [1,1]

Comment:

SIMUL8 spreadsheets do not get initialised, meaning that their content remains when a simulation is Reset. This is occasionally undesirable so Clear Sheet is a way of emptying all content.

Complete SQL Insert or Update

Definition:

Complete SQL Insert or Update
SIMUL8 SQL Database

Description:
Closes the link to a nominated database. Select the database from the list of Aliases listed in the SQL Database Queries list.

Comment:
Use this command to close a link to a nominated database, so that subsequent search or insertion can be undertaken from the first record in the database.

Copy Simulation Object

Parameters

Original Object
Object Data Item

Description:

Creates a new object by making a copy of another

Count Work Items in Region

Definition:

Count Work Items In Region
Conveyor name
Start Point for count
Length of region
Global Data Item to receive the count

Description:

This command returns the number of items currently in a certain area of a conveyor. Nomintae the conveyor to be examined and then, counting from the back (the end the items are loaded onto) nominate the start point for the count the region is the length of area to be examined counting forward to the head, or unload) point.
If the conveyor is 10 m long and the Start point is set at 7and the Length of Region is set at 3 then the number of items found in the 3m length between the Unload point and the start point.

Create Simulation Object

Parameters:

Create Simulation Object
Object Data Item

Description:

Creates an object of the same type as Object Data Item parameter

Comment:

See also:

Erase Simulation Object

Delay for Seconds

Parameter:

Number of Seconds

Description:

Stops the model for specified number of seconds. Model continues after the time has elapsed. The main tool bar shows "Pausing" during the time. Clicking the word "Pausing" will continue the model immediately.

Comment:

Useful when model will be used to demonstrate a particular issue which requires the simulation to slow down or stop for a time at key times.

Delete Work Item

Parameters

No parameters are required

Description:

The Current Work Item is removed from its storage bin and deleted from the model

See also:

Move Work Item To
Empty Simulation Object

Deschedule Event

Definition:

De-Schedule Event

Visual Logic

Description:

When Schedule Next Event has been used it may be that the Event scheduled is not required. This command allows the Scheduled Event to be removed from the scheduled event list

Comment:

Nominate the VL to be removed.

See also:

Schedule Event

Simulation Monitor

Display+

Display Image

Parameters:

Image

Window

X coordinate

Y coordinate

Description:

Places an image from the Image Library onto the simulation window, or a sub-window if preferred, at location X, Y.

Display Text

Parameters:

Text
Window
X coordinate
Y coordinate

Description:

Creates a text box and places it on the simulation window or a nominated sub-window, at location X, Y.

Clear Image

Parameters:

Image
Window
X coordinate
Y coordinate

Description:

Deletes the image at location X, Y. The image name, location and Window must match those assigned ot the image for the command to be successful.

Clear Text

Parameters:

Text
Window
X coordinate
Y coordinate

Description:

Clears a text box at location X, Y on the nominated Window. If the coordinates and window do not match a text box the command is not successful

Clear All Display+

Parameter:
No parameter requiered
Description:
Deletes all text and images that have been created using Display+

Display main sheet

Parameters:
No parameters required

Description:
Displays the currently selected main sheet just like pressing Show Data Sheet button on toolbar.

Comment:
Use from Visual Logic in Wizards or Spreadsheet buttons. Sheets are useful for storing or collecting data, and also for use as in interface.

See also:
Set main sheet

Display Message

Parameters:
Message Text

Description:
Displays message text on screen with OK button. Model stops until OK clicked

Comment:

Useful for checking your logic or displaying special information to user. Can also be used to display the value of a Global Data Item on the message box by adding + variable name:

```
VL SECTION: Example VL
 SET Var1  =  Queue for Work Center 1.Count Contents
 Display Message    "The number of items in the store are: "+Var1
```

Empty Simulation Object

Parameter:

Simulation Object
(Storage Bin, Work Center, Conveyor)

Description:

Removes all work items from the object and deletes them from the model

See also:

Move Work Item To
Delete Work Item

Erase Simulation Object

Parameter:

Object Name

Description:

Removes a simulation object from the simulation

Comment:

This is the opposite of Create Simulation Object. The nominated object is deleted from the simulation.

Extract from CSV

Definition:

Extract from CSV
Full Text
First Field

Description:

Extracts text from a Comma Separated Value field.

Extract Text

Definition:

Extract text
Full text
Start
Length
Extracted Text

Description:
Extracts text of a desired length from a string of text, and writes it into a location, usually a Global Data Item.

File Operators:

Append to File

Parameters:
File Name
Text
Description:
Adds a text string, either typed in or from a Global Data Item to the end fo a file

Create File

Parameters:
File Name
Description:
Creates a new file of the desired name and location. This line is ignored if the file already exists

Read File

Parameters:
File Name
Text
Description:

Reads the next location in a file to a SIMUL8 global data item or a cell in a spreadsheet

Begin Reading File

Parameters:

File Name

Description:

Tells SIMUL8 to prepare to read data from a file.

Close All Files

Parameter:

No parameters required

Description:

Shuts down the links to any Read or Append files.

File To Sheet

Parameters:

File name

Global Data Item Sheet

Description:

Allows the contents of a .txt, .csv, .rtf file to be imported to a SIMUL8 internal spreadsheet.

Find Text

Definition:

Find Text

Search for

Search in
Location found

Description:
Searches for the location of a text string in a nominated location (eg Global Data Item), and returns the location of the start of the string of text. the location is normally written to a Global Data Item.

Get Current Object

Definition:
Get Current Object
Simulation Object

Description:
Return the name of the object that has referenced the Current piece of Visual Logic. The Object Name is normally written to a Global Data Item

Comment:
Use this command when Calling a common piece of stand alone Visual Logic.

Get From Database Field

Definition:
Get From Database Field
SIMUL8 Global Data Item
SIMUL8 SQL database
Field

Description:

Looks up a nominated field in a database, and write the value returned to a Global Data Item. The SQL Database must be already referenced through the SQL Database Queries field (see Object menu). Each iteration returns the next value in the database.

Get from EXCEL

Parameters:

Global Data Item (Number, Text, or Spreadsheet location)
EXCEL Sheet name in format "[????.XLS]Sheet1"
Column in Excel
Row in Excel
Width in Excel (1 for single cell)
Height in Excel (1 for single cell)

Description:

Copies information from EXCEL sheet into a **SIMUL8** Global data item. If the Global data item is a spreadsheet location then Width and Height can be used to copy an area of a spreadsheet from EXCEL to **SIMUL8**.

Comment:

Use at the start of a run (during RESTART logic) to copy in relevant information for this run.
If the EXCEL Sheet name braces contain no file name (e.g. []Sheet1) then the file name from the Excel Extension dialog is automatically used.

VL SECTION: Example VL

```
Get from EXCEL    data[1,1] ,  "[Book1.XLS]Sheet1" ,  5 ,  5 ,  10 ,  10
```

This block will paste into the SIMUL8 sheet "data", starting at location 1,1 the contents of the excel file Book1, Sheet1. The Copy will start at location 5,5 and will copy an area 10 columns wide and 10 rows deep.

See also:
Set in Excel

Get Held Resource Count

Definition:
Get Held Resource Count
SIMUL8 Global Data Item
Resource

Description:
Returns the number of resources held by the Current Work Item. If this command is not called by a Work Center then the Select Command should be used to avoid an error message.

Get latest copy of

Parameters:
Original Object
Object Data Item

Description:
Write into a Global Data Item the latest copy of an object, that was copied using the Copy Selected Objects command

See also:
Copy Selected Objects

Get Object Location

Definition:

Get Object Location
X
Y

Description:

Returns the X and Y locations of a nominated object

Get PC Clock

Definition:

Get PC Clock
String

Description:

Returns the PC clock time

Get Result

Parameters:

Global Data Item (Number)
Result Type (Current Run, Average, Confidence Limit etc)
Result (Choose from any on the results summary)

Description:

Copies a result summary value to a Global Data Item.

Comment:

Really useful for compiling results reports or basing your next run on the result of a previous run.

See also:
Set in Excel

Get Text Length

Definition:
Get Text Length
Text
Length

Description:
Calculates the length of a string of text and writes it to a Global Data Item

Get VL Random Number Seed

Definition:
Get VL random Number Seed
Current Seed

Description:
Returns the seed information from the current random number stream. This is intended for use by simulation experts who require ultimate control over Random Number streams

See also:
Set VL Random Number Stream

If...ElseIF....Else

Definition:

IF

Condition

Visual Logic Sub-Block

Description:

Tests the condition and if this is successful obeys the lines of Visual Logic in the sub-block.

Definition:

ELSEIF

Condition

Visual Logic Sub-Block

Description:

If and only if none of the preceding IF / ELSEIF lines in a continuous sequence at this indent level have been successful ELSEIF tests the condition and if this is successful obeys the lines of Visual Logic in the sub-block.

Definition:

ELSE

Visual Logic Sub-Block

Description:

If and only if none of the preceding IF / ELSEIF lines in a continuous sequence at this indent level have been successful obeys the lines of Visual Logic in the sub-block without testing any further conditions.

VL SECTION: Example VL

```
IF Queue for Work Center 1.Count Contents  <=  5
  Display Message    "less than 5 items"
ELSE IF Queue for Work Center 1.Count Contents  <=  10
  Display Message    "between 5 and 10 items"
ELSE
  Display Message    "more than 10 items"
```

This block will display only one message, depending on the numebrof items in the store.

Insert Into SQL Database

Definition:

Insert Into SQL Database
SIMUL8 SQL Database
SQL Insert Command

Description:

Nominates an insertion point for a string of text or a variable into a nominated database table. Use the Insert into SQL Database command to complete the insertion.

Job Matrix to Sheet

Definition:

Job Matrix to Sheet
SIMUL8 Spreadsheet [c,r]

Description:

copies the Job Matrix into a SIMUl8 spreadhseet at the desired location. This is intended to make it easier for end users to edit and amend Job Matrix data, especially when using Templates.

See also:
Job Matrix
Sheet to Job Matrix

Link Simulation Objects

Parameters:
Source Object
Destination Object
Travel Time
Description:
Links two simulation objects with a routing arrow

Comment:
Normally used as part of a Dialog to enable a user to configure a simulation.
See also:
Create Simulation Object
Erase Simulation Object
UnLink Simulation Objects

Load SIMUL8 module

File Name - the .MS8 file
X - Horizontal Offset for Copy
Y - Vertical Offset for Copy

Description:
Loads a module containing part of a simulation.

Loop

Parameters
Starting value of global data item
Name of global data item used to count the loop
Ending value of global data item
Visual Logic Sub-Block

Description:
(1) The global data item is set to the starting value.
(2) If the global data item if <= to the Ending value then Visual Logic Sub Block is obeyed otherwise stop the loop.
(3) The global data item is incremented by one
(4) Go back to (2) and repeat

```
VL SECTION: Example VL
 LOOP 1 >>> Var1 >>> 10
   Display Message    "Current value of Var 1 is "+Var1
```

This block will count from 1 to 10, displaying the value of "Var 1" in order.

Loop Object

Parameter

Object Global Data Item

Description

Loops through all objects of the nominated type, selecting each as the Current object and allowing an operation to be undertaken on the object.

This block loops through all Work Exit Points and setc the image of each in turn to Aircraft.bmp.

```
LOOP WORK EXITS with Var1
  Set Object Image    Var1 ,  Aircraft
```

Move To Queue

Parameter:

Destination

Position

Description:

The Current Work Item is removed from its storage bin and moved to a different storage bin. The location within the new store must be nominated or the item will be placed at the end of the store.

See also:

Delete Work Item

Empty Simulation Object

Open Database

Definition:

Open SQL Database
SQL
Filter

Description:
A data source must be opened before communication can be undertaken. This command allows a table within the data source to be nominated (opened) and a Filter applied allowing a limited search to be undertaken.

Open Dialog

Definition:
Open Dialog
Dialog Name

Description:
This command open a SIMUL8 Dialog. The simulation will pause while the dialog is open.

See also:
Custom Dialog

Open Help File

Parameter:

File Name

Description:

Opens a file (hlp, doc, htm or txt)
Will NOT open exe files.

Comment:

Use from Visual Logic in Wizards or Spreadsheet buttons

Percent Route Out Adjust to 100

Parameter:

Leaving Work Center

Description:

Pro-rata adjusts all percent route out from the work center so that they add to 100%.

Comment:

This facility is rarely required. You should normally use Set Route Out Percent to correctly see all percentages.

See also:

Set Route Out Percent

Play Sound

Definition:

Play Sound
Sound File

Description:

Plays a .wav file. The file must be located in the same file as the SIMUL8 file containing the Play Sound command.

Recorded Data to File

Definition:

Recorded Data to File
File Name
Simulation Object
Result Type

Description:

Writes to a nominated file the desired selection of results. Specify the path to the file inside the inverted commas, then specify the object and the result to be recorded.

Refresh Windows

Parameter:

No parameters required

Description:

Redraws all Windows

Comment:

Use after creating or copying objects. This command may cause a brief screen flicker as the redraw is undertaken so for presentation purposes its use should be minimised.

Remove Resource Requirements

Definition:

Remove Resource Requirement
Work Center
Resource

Description:

Removes the requirement from a Work Center. An alternative approach is to Set Resource Requirement to 0. the advantage of Remove Resource Requirement is that all reference to the Resource is removed from the work center.

See Also

Set Resource Requirement

Remove Results

Parameter:

Object

Description:

Removes results for the nominated object from the Results Summary

Comment

Use to amend the contents of the Results Summary window, usually between runs where a new item of interest has been identified by VL.

ReSchedule Arrival

Parameter:

Work Entry Point

Description:

Change time of Next Arrival

Comment:

Uses the timing information in the work entry point (probably just changed in previous Visual Logic command) to reschedule next arrival through this work entry point.

See also:

Set Distribution Parameters

Reset

Parameter:

Random Number Stream Set

Description:

The clock is set to zero, the random number generators reset using the new stream set number and all simulation objects initialized. If the Random Number Stream Set is zero then the stream set is not changed.

RunModel

Parameter:

End Run Time

Description:

Runs the model until End Run Time. This sets Results Collection Period = End Run Time minus Warm Up Period

Comment:

Can be attached to a Dialog button to run the model when the button is clicked.

Save Model

Parameters:

Filename Text string
(Valid file name or blank)

Description:

Saves the model to disk as File Name. If File Name is blank then the current filename of the model is used. Remember to use quotation marks either side of the name.

Schedule Event

Schedule Next Event is a Visual Logic Command.

Schedule Next Event was designed to be used with Components to recreate Time Check functionality, but it can be used as a conventional piece of Visual Logic

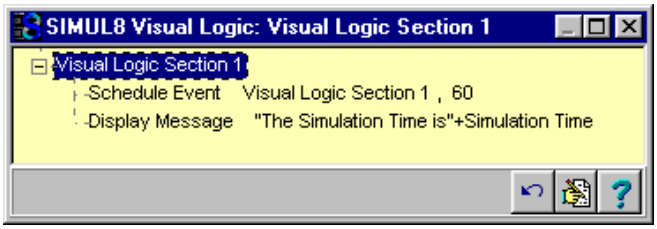
Different Components in the same simulation can need different rules to run at different times. For maximum flexibility SIMUL8 creates events that can reschedule themselves, by using the Schedule Next Event command.

Example:

Say you have a line of code that makes a message box pop up and display the current simulation time. It does this first at time 0, when the simulation starts, and every 60 minutes after that. Time Check Logic will do this but in Components you need to use something else. Time Check logic is not listed as an Event that a Component can assign VL code to.

So: at Time 0 display the message and SCHEDULE the next message box to pop up 60 minutes later. At time 60 again display the box and schedule another message box at time 120 and so on.

The VL Code for this example is:


SIMUL8 Visual Logic: Visual Logic Section 1
Visual Logic Section 1
Schedule Event Visual Logic Section 1 , 60
Display Message "The Simulation Time is"+Simulation Time

Create a Component and assign this block of code to Reset VL using the Component Detail Options

To recreate Time Check use the Schedule Event Visual Logic command. This command specifies a time that a piece of Visual Logic will run. Visual Logic can reschedule itself, effectively recreating the functionality of Time Check.

Schedule Next Event can be used in many different places for many purposes. So you can have as many Time Check equivalent pieces of Logic running as you need

Select Current Work Item

Parameters:

Simulation Object
(Storage Bin, Work Center, Conveyor)
Position in Object
(0=tail, 1=head, 2=second in queue etc)

Description:

Selects a work Items as the current work item. If there is not a work item at the selected location the current work item becomes zero.

See also:

Move Work Item To
Delete Work Item
SET (a label)

Select Simulation Object

Parameters:

Object

Description:

Selects a simulation object for copying

See also:

Copy Selected Objects
Clear Object Selection

Select Work Item on Conveyor

Parameters:

Conveyor
Start of Search Region
(metres from front of conveyor)
Length of Search Region
(metres from front of conveyor)

Description:

Selects a work items as the current work item if it is the first work item found when searching a part of a conveyor starting at "start" distance from the front of the conveyor and ending at start+length. If there is not a work item at the region the current work item becomes zero.

Comment:

The "front" of a conveyor is the point where the work items travel to while on the conveyor. To select a work item which is ready to be removed from the conveyor because it has traveled the full length of the conveyor set the start and length parameters to zero.

See also:

Move Work Item To
Delete Work Item
SET (a label)

SET command

Parameters:

A single data item
(Label, Global Data Item, Simulation Object parameter etc)
=
A value
(An expression)

Description:

Sets the single data item such as a global data item, or a particular label on the current work item or a property of a simulation objects (like the max size of a storage bin) to the value on the right hand side of the "=".

VL SECTION: Example VL
SET Var1 = Queue for Work Center 1.Count Contents

This block sets the value of Global Data Item "Var 1" to the number of items in the store.

Set Clock Properties

Parameters:

Start of Day
Length of Day
Days in Week

Description:

Changes Clock Properties.

Set Collect Number

Parameters:

Input Simulation Object
(Where the work items come from)
Collect Number
(Number of items to be collected)
Work Center
(Where the work items are collected into)

Description:

For work centers which use COLLECT routing in, sets the number of work items to be collected from a particular route in.

Comment:

The "Input Simulation Object" must already be in the list of objects "routing in" to the work center.

Set Distribution Parameters

Parameters:

Distribution Name
(Named Distribution)
Distribution Type
(E.g. "Normal", "Fixed" etc - choose from list)
Parameter 1
(Purpose depends on Distribution Type)
Parameter 2

(Purpose depends on Distribution Type - not used in some cases)
Parameter 3
(Purpose depends on Distribution Type - not used in some cases)
Parameter 4
(Purpose depends on Distribution Type - not used in some cases)

Description:
Changes a named distribution.

VL SECTION: Example VL
Set Distribution Parameters Distribution1 , Normal , 10 , 2.5 , 0 , 0

This example changes Distribution1 to a Normal Distribution with mean 10 and standard deviation 2.5. Parameters 3 and 4 are not required.

Set Efficiency

Definition:
Set Efficiency
Simulation Object
Efficiency

Description:
Sets the Automated Efficiency percentage of a Work Center.

See also:
Efficiency and Breakdown

Set Field Number

Definition:

Set Field Number
SIMUL8 SQL Database
Field
Number

Description:

Sets a numeric field in a database. This commadn creates a new record in the database table. Nominate the database to be added to by using the Open Database command, then use the Set command to place a new record into the database

Set Field Text

Definition:

Set Field text
SIMUL8 SQL Database
Field
Text Value

Description:

Adds a new database record to a database table. Use the Open Database command to open the link prior to using this command.

Set in EXCEL

Parameters:

Global Data Item (Number, Text, or Spreadsheet location)
EXCEL Sheet name in format "[????.XLS]Sheet1"
Column in Excel
Row in Excel

Width in Excel (1 for single cell)
Height in Excel (1 for single cell)

Description:

Copies information to EXCEL sheet from a **SIMUL8** Global data item. If the Global data item is a spreadsheet location then Width and Height can be used to copy an area of a spreadsheet from **SIMUL8** to EXCEL.

Comment:

Use at the end of a run (during ENDRUN logic) to copy relevant results information to EXCEL.
If the EXCEL Sheet name braces contain no file name (e.g. []Sheet1) then the file name from the Excel Extension dialog is automatically used.

VL SECTION: Example VL

```
Set in EXCEL    data[1,1] ,  "[Book1.XLS]Sheet1" ,  5 ,  5 ,  10 ,  10
```

This example copies data form the SIMUL8 sheet "data" and pastes it into Excel Book1. The area copied is 10 columns by 10 rows, and the copy starts at position 1,1 from "data" and the paste into Excel at 5,5

See also:

Get from Excel

Set Next Time Check

Parameters

Time

Description:

Change time of Next Time Check

Set Object Image

Parameters

Simulation Object
Image Name

Description:

Changes the image used for the object. The image must be contained in the Images saved with the SIMUL8 file, and then chosen from the list.

Set Object Distribution Parameters

Definition:

Set Object Distribution Parameters
- Object
- Distribution to be changed
- Dsitribution Type
- Parameter 1
- Parameter 2
- Parameter 3
- Parameter 4

Description:

Changes the type (eg Normal, Exponential etc) of distribution used by an object. Choose the object, then the Distribution to be changed (interarrival time, cycle time, change over, batch size), then set the parameters. Not all the parameters need to be set.

Set Object Location

Parameters:
- Object
- X - Horizontal Location
- Y - Vertical Location

Description:

Positions a Simulation Object at a location.

Set % Within Time

Parameters:

Object
Time

Description:

Sets the Time used for Results Percentages

Comment:

Use for work exit points and storage bins. Should only be used during Reset or while simulation is at time zero.

Set Prob-Profile Distrib Column

Parameters:

Distribution Name
(Probability Profile Distribution)
Column Number
(1= left most column in dialog)
Sample Value
Percentage Chance
(0-100)

Description:

Sets the sample value and percentage values for a single column (cell) in a probability profile distribution. Percentage chance values for columns to the right of the "Column Number" column are adjusted so that the total percentage = 100.

VL SECTION: Example VL
LOOP 1 >>> Var1 >>> 10
Set Prob-Profile Distrib Column Distribution1 , Var1 , Var1 , data[1,Var1]

This loop will set the values of the columns in a Probability Profile to the values contained in a sheet. Var1 increments form 1 to 10 setting the column number, the sample value and also the location in the sheet to get the values form.

Comment:

As columns to the right are adjusted to ensure total percentage = 100 you are recommended to only set columns in numerical (left to right) sequence.

Set Resources Required

Parameters:

Work Center
Resource
Minimum Number Required
Maximum Useable Number

Description:

Changes the quantity of resources required at a work center.

Comment:

In most cases the Maximum and Minimum parameters will be the same (For exceptions see Resource Details Dialog). The Resource must already be connected to the work center. This command does not make new connections. 0 is a valid numbers (so that none of a particular resource are required sometime).

See also:

Clear All Resources Required

Set Resource Travel Time

Definition:

Set Resource Travel Time
Resource
From Location
To Location
Travel Time

Description:

Changes the travel duration of a Resource between locations. The Resoucre and locations must already exist in the simulation.

See also:

Mobile Resources

Set Route In Priority

Definition:

Set Route In Priority
Work Center
Object
Priority

Description:

Changes the order in which Objects are connected into the work center.

Set Route Out Label

Parameters:

Object
Label

Description:

Changes the routing out label

Set Route Out Percent

Parameters:

Leaving Work Center
Percent
Destination Object

Description:

When Routing Out Discipline Percent is used this changes the percentage of work items which are sent to a particular destination.

Comment:

Normally you will set several Route-Out-Percents in sequence because the complete list of route out percents should add to 100%. If you do not change several so that the total in 100% **SIMUL8** will not correct this error for you (until you interactive use the Routing Out Dialog). If a work center leaves a work center which has a set of percents which do not add to 100% any surplus or deficit affects the percentage of work items going to the final objects in the destination list.

If you want **SIMUL8** to automatically correct the total to 100% by pro-rata adjustment of all percentages then use Percent Route Out Adjust to 100.

See also:

Percent Route Out Adjust to 100

Set Route Out Discipline

Parameters:

Leaving Work Center
(Work center where routing out applies)
Routing out method
(e.g. "Circulate" - choose from list)

Description:

Changes the routing out method.

VL SECTION: Example VL
IF Simulation Time < 120

```
  Set Route Out Discipline    Work Center 1 ,  Circulate
ELSE
  Set Route Out Discipline    Work Center 1 ,  Shortest Queue
```

This example changes the Route Out discipline from Circulate to Shortest Queue if more than 120 time units have elapsed.

Set Route Out Priority

Definition:

Set Route Out Priority
Work Center
Object
Priority

Description:

Changes the order in which Objects are connected out of the work center.

Set Shift Days

Parameters:

Shift
Day Code

Description:

Sets which days a shift is on.

Comment:

Day code: 0=every day, 1MTWTFSS=day pattern eg: 10010001 = wed and sun only

Set Shift Resources

Definition:

Set Shift Resources
Shift Name
Resource
Available

Description:

Sets the number of resources available during an existing shift. Use this to alter the number of resources available, however care should be taken as the Shift Work Pattern set through the Shift Patterns dialog can override this.

Set Shift Times

Definition:

Set Shift Times
Shift Name
Start Time

End Time

Description:

Sets the Start and Stop times of a Shift. Use in conjunction with Set Shift Days and Set Shift Resources to control all aspects of a shift.

Set Travel Times

Definition:

Set Travel Times
Leaving Work Center
Time
Destination

Description:

Use this command to alter the travel time between 2 suitable objects. Travel Time applies only form Work Center to Store, Work Entry Point to Store, or Work Center to Work Exit Point.

Items already in transit to a destination do not have their travel time altered, so Work Items can be made to overtake each other.

See also:

Travel
Travel Link

Set VL Random Number Seed

Definition:

Set VL Random Stream
New Seed

Description:

The seed number used by SIMUL8 to control the Random Numer Streams can be altered using this command. This is recommended for use by simulation experts only, as it can alter the continuity of random numbers used in the simulation, and hence may influence the results.

Set Work Item Image

Definition:

Set Work Item Image

Image Name

Description:

Changes the image used for the Current Work Item

Sheet to File

Parameters:

File name

Global Data item sheet

Description:

Exports the contents of a SIMUL8 internal spreadsheet to a file. The file can be .txt, .csv, . .rtf. This allows results or other data to be collected in SIMUL8 internal arrays and then exported to another application for analysis.

Sheet to Jobs Matrix

Definition:

Sheet to Job Matrix

SIMUL8 Spreadsheet [c, r]

Description:

Nominate a SIMUL8 spreadsheet to copy to the Job Matrix. This command allows entries to the Job Matrix to be altered without recourse to the Object menu, and is designed to facilitate the use of Templates.

See also:

Templates
Job Matrix to Sheet
Job Matrix

Signal VBA

Parameters:

Text String

Description:

Sends a text message to EXCEL/VB.

Comment:

Although this is mostly useful for back compatibility with past **SIMUL8** models which used EXCEL/VB to control logic, it also lets you create more signals to EXCEL/VB to better control you model from EXCEL/VB should you choose this as your preferred extension language.

Simulation Speed

Parameters;

Speed %
(0-100)

Description:

Changes the current running speed (equivalent to moving the speed control slider on the main window). 0 stops the model running. 100 switches off all graphics updates to maximize speed.

SQL Command

Definition:

SQL Command

SIMUL8 SQL Database

SQL Command

Description:

This command allows SQL not contained in the standard SIMUL8 SQL Library to be typed in. SIMUL8 Adheres to the SQL99 standards. Some database vendors use marginally different syntax for identical commands, hence it is possible that the standard SQL Library will return an error in certain circumstances.
Type the SQL to be used insed the inverted commas. If Variables (Global Data Items) are to be used as part of this command use the syntax:
"SQL command text string"+Var1
to include this within the signal to the data source

Stop Model

Parameter:

No parameter required.

Description:

The model stops running.

Unlink all out links

Parameter:
Object

Description:
Removes all exit route arrows from the nominated object.

UnLink Simulation Objects

Parameters:
Source Object
Destination Object

Description:
Removes link between two simulation objects

See also:
Link Simulation Objects

Until

Parameters:
Condition
Visual Logic Sub-Block

Description:
Obeys the lines of Visual Logic in the sub-block and then tests the condition and if this is Unsuccessful then repeats. Continues like this until the test is successful.

Comment:

Significantly different from WHILE. in that the sub-block is always obeyed at least once.

Update SQL Database

Definition:

Update SQL Database
SIMUL8 SQL Database
SQL Update Command

Description:

Updates a record in an SQL compatible datasource. This does not create a new record but can be used to find and then update an existing record.

While

Parameters:

Condition
Visual Logic Sub-Block

Description:

Tests the condition and if this is successful obeys the lines of Visual Logic in the sub-block. Then repeats. Continues like this until the test is unsuccessful.

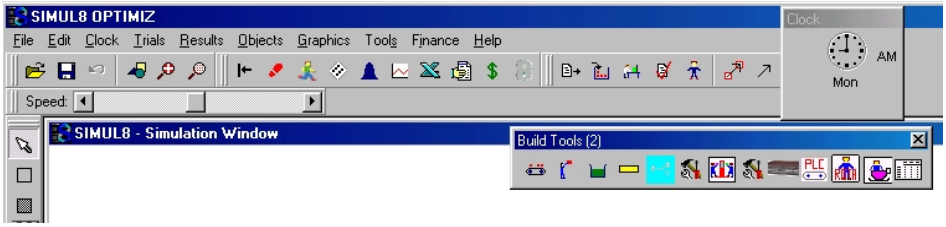
Comment:

Significantly different from UNTIL in that if the condition is unsuccessful on the first attempt the sub-block is not obeyed even once.

SIMUL8 Components

What are Components?

SIMUL8 Components are pre-built sections of a simulation. Driven by mouse clicks, they are designed to allow commonly used functions to be programmed onto the toolbar for re-use, and they can be licensed and sold on to other users.



A typical screen layout with Components displayed on the Build Tools 2 Toolbar

SIMUL8 Components are intended to help build simulations in two ways:

- reducing the need to re-build certain elements of a simulation over and over, for example a combination of work centers and stores that is common in your simulations
- reducing development time of more complex elements (like the internal working of a manufacturing machine or a switching device in a computer network) as you can benefit from the work of another simulation builder.

There are Tutorials designed to illustrate Component creation and use below.

For more advanced applications it is possible to build Components that include user configurable elements, so that a Component can ask some easy questions and, depending on the answers, alter its internal operations.

If you have built a component that has a general use then you can license and sell it through the support web site: www.support.SIMUL8.com/components

Installing and Packaging Components

Components can be downloaded from www.SIMUL8.com/components.

Downloaded Components are supplied in *.zip format. To install a downloaded component select the File menu, Components option, then Install Component.

Browse to the appropriate location and click OK. The Component will be installed and added to your Toolbar.

Packaging a Component is the reverse of this procedure. Select Package Component form the File menu, browse to the appropriate OS8 (component) file and click OK. The file will be packaged as a .zip file ready for distribution or for upload to www.SIMUL8.com/components.

Quick Start: using a Component

This section shows how to use the Switch component supplied with **SIMUL8** V7. Later in this section there is a tutorial showing how to build this component.

Using **SIMUL8** Components is as easy as every other SIMUL8 Object.

Hover the mouse over a Component to see its name, Drag and Drop the Component onto the screen to use it in a simulation. Link into and out of a Component just like every other object.

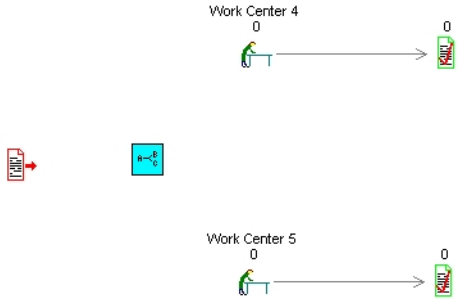
Click once to open the properties of the Component. A dialog will appear that may give you further instructions about how to configure the Component.

Tutorial 1: Using a pre-built Component.

Select the Switch Component on the Build Tools 2 Toolbar.

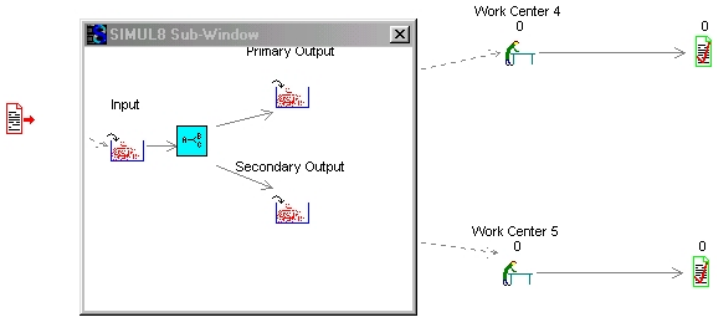
Drag and drop it to the Simulation Window. Create a Work Entry Point, 2 Work Centers and Work Exit Points.

Arrange the objects on the Simulation Window like this, but don't connect the component yet.



Click on the Switch Component. Follow the instructions - right click on the Component and select Remove Object Layer. Make sure the Net (or dotted line) around the Component is turned off, by clicking on a blank section of the screen.

The Component will be unpacked to a sub-window. Link into and out of the Storage bins in the normal way - connect the Work Entry Point to the Input storage bin and the Primary Output to Work Center 4. The Secondary Output should be connected to Work Center 5.



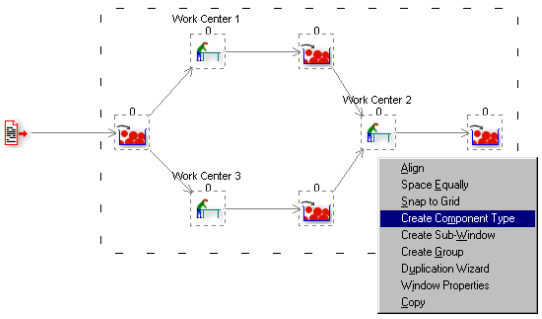
To configure the component click on the symbol on the screen and follow the instructions.

You are now ready to run the simulation.

Some Components may not need to be unpacked. Their instructions will let you know what to do.

Component Building

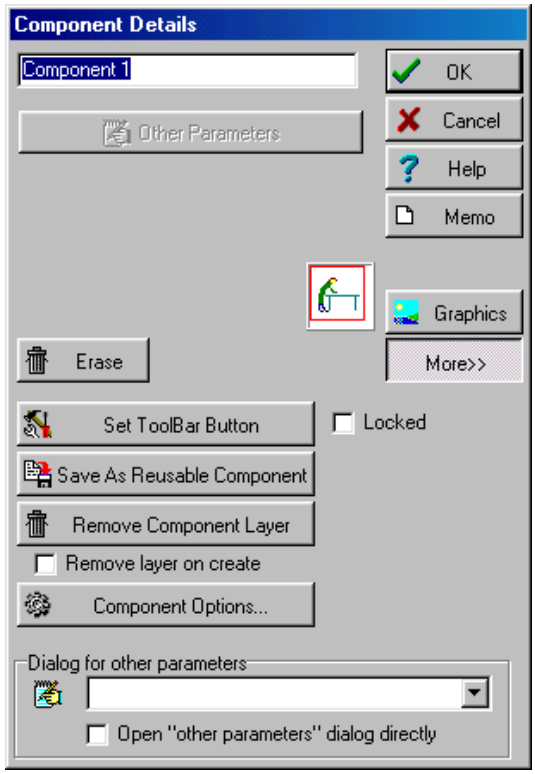
Build a simulation and select the objects to be included in the Component. RIGHT click to open the options menu. Select the Create Component option.



This places the selected objects inside a new Component object, that can be moved around the window. It will behave as though it is a normal SIMUL8object.

Click on the new component icon on the screen and the More button to view the component properties.

In addition to the normal OK, Cancel; Help and Memo buttons there are:



Set Toolbar Button: change the graphic image used for the Toolbar button

Save as Re-Usable Object: save this Component and place a new button on the toolbar to allow drag-and-drop access

Remove Object Layer: unpack the Component to a sub-window

Remove Layer on Create: when checked the objects making up the component are placed directly onto the screen, without the normal Component container.

Component Options: licensing and advanced object control options

The Graphics control is used to alter the on-screen image of the Component

Dialog For Other Parameters is dealt with later in this section.

Saving a Component

To re-use a component select the Save As Re-Usable Object button. This saves the Component (to the Object Repository in the **SIMUL8** directory) and creates a new button on the Build Tools 2 toolbar.

> *Hint: if you prefer the toolbar bar not to float over your screen drag and drop it to your preferred location and the select Tools, Preferences, Display and untick the Toolbars at Default Position option.*

Edit the default graphic before saving by using the Set Toolbar button, and alter the on-screen image by using the Graphics button before saving.

Re-using a Component

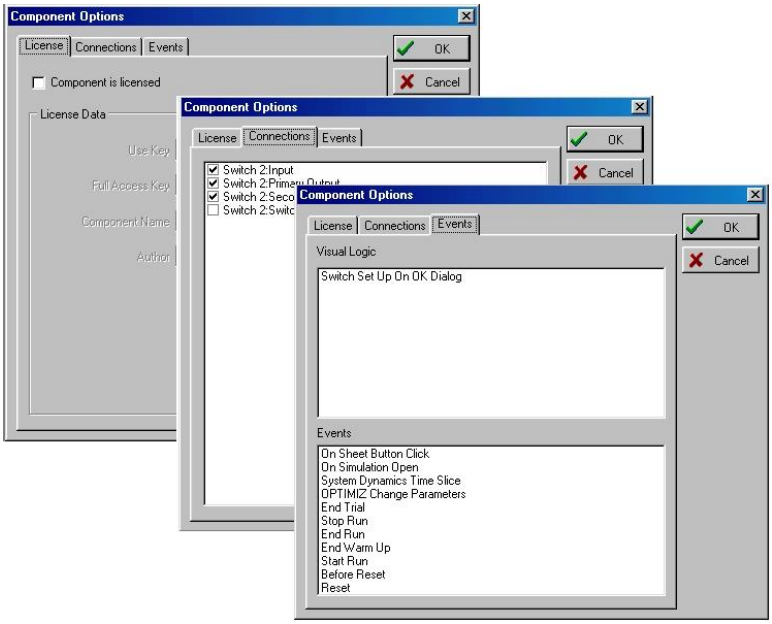
Drag and drop the Component in the same way as any other object onto the screen. Link into and out of the Component

To unpack a Component Drag and Drop it onto the **SIMUL8** window. Click on the screen to de-select the Component (the dotted line or selection net will disappear). Now, Right Click and select the Remove Object layer option.

The Component will now be unpacked to a sub-window.

Component Options

The Component Options button opens a tabbed dialog.



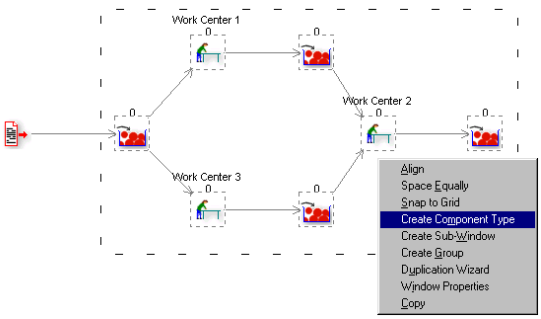
The License tab is used when using a Licensed Component, perhaps purchased through support. **SIMUL8**.com/ or when creating a component for sale.

The Connections Tab is used to define the Inputs and Output connections from the Component. Components that have only one input and one output can be connected to other objects without being unpacked.

The Events tab allows Visual Logic routines to be assigned to SIMUL8model events.

Tutorial 2: Creating a Simple Component.

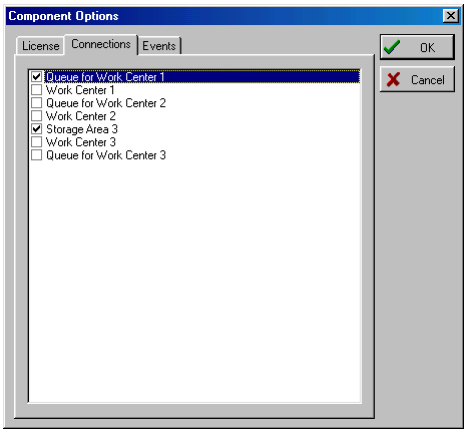
Create a simulation as shown below:



Select the items as shown and right click. Select Create Component.

The Component icon will now be displayed on the screen.

Click the Component icon and the Component Details will be displayed, select the More button and then Component Options, Connections tab to display the full set of objects contained in the Component.



Tick the box beside the object that represents the Input and Output from the Component.

When the Component is placed onto the screen this designates the objects inside the Component that other **SIMUL8** objects will connect to.

If this screen is not completed then **SIMUL8** will identify an appropriate input and output object.

Save the Component using the Save as Re-usable Object button. The Component should now be available on the Toolbar. Place the mouse over the new Component without clicking. A Tip will appear confirming the name.

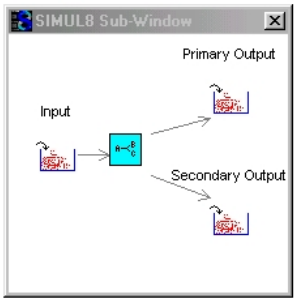
It is now possible to drag and drop the Component onto the simulation window and connect other object into and out of it, and to Remove the Object Layer so that the Component is unpacked to a sub-window.

The remainder of this section is based around the Switch component supplied with **SIMUL8**, going through the steps to create this component.

Hierarchical Components

Hierarchical Components are Components saved inside other Components. This allows different levels to be made available to users, and multiple in and out connectors to be utilized.

Drag and Drop the Switch Component to the Simulation window, Right click to remove the Object Layer. This exposes the Connector level - storage areas that can be linked to other objects.



Switch Component Connector Level view

At this level, the Switch Internals Component can be seen, and the Input, Primary and Secondary storage bins represent the in and out connectors.

If the first level of this component is not removed any connection out of the Component will be determined by **SIMUL8**.

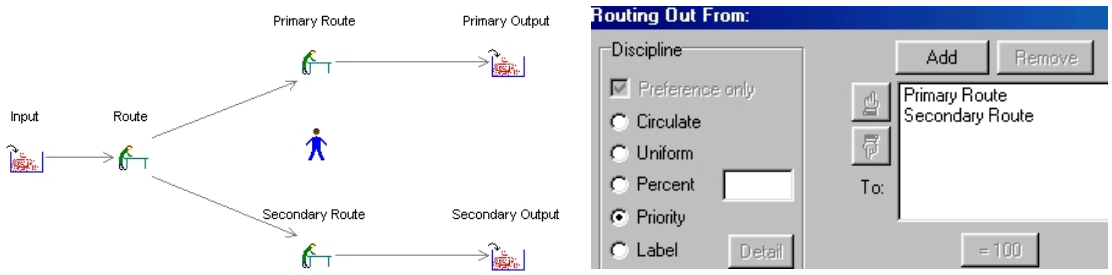
The Switch Internals Component does not need to be saved separately. It is straightforward to save Components as part of other components.

Tutorial 3: Creating a Hierarchical Component

This Tutorial is based on the Switch component supplied with **SIMUL8**.

This Component routes items along a Primary route at certain times, and along the Secondary route at other times. The Primary Route is available only when a Resource is available.

Create the structure as shown, and select the Priority Routing Out Discipline from the Route work center. Make sure that the Primary Route is listed first. Set the timing of all the work centers to 0, Fixed as these work centers represent electronic components that take no time.



Route work center - Routing Out Detail

Create a shift pattern for the Resource. Attach the Resource to the Primary Route work center. This means that the work items will travel along the Primary Route when the Resource is "on shift".

Select the 3 Work Centers and Resource by drawing a net around them, now right click and select Create Component. Name the Component "Inside the Switch".

Next, Select all the objects, including the Inside the Switch Component, again right click and select Create Component. This creates a second, higher level component, that contains the Inside the Switch component as well as the storage bins.

Save this with the name "Switch Test".

Additional Component Toolbars

If you create or install a number of Components you can quickly use the available space on the Build Tools 2 toolbar. To create additional Toolbars, so that Components can be arranged in sets or functional groups, create a new folder in the SIMUL8 directory, Object Repository folder.

The new folder will automatically create a new toolbar housing the components within the folder.

Component Dialogs.

Dialogs are pop-up boxes that can provide explanations, ask questions and accept answers.

Components can be complex and may require some configuration, and dialogs are a powerful and easy way to create this type of interface.

Tutorial 4: Adding Dialogs to Components

Create a Dialog using the Tools menu, Dialogs option. Use the Title option to write "My First Dialog" onto the Dialog. Use the View option to check out the Dialog appearance.

Select the Switch Test Component and click to open the Component Details. Use the Dialog for Other Parameters drop down list at the bottom of the Component Details screen to Add the Dialog name. Tick the Open Other Parameters Dialog Directly check box. This opens the Dialog when the Component is clicked on.

Create a further Dialog and attach this to the Inside the Switch Component. The Dialogs will open whenever the Components are clicked upon.

When a Dialog is displayed you can access the Component by holding down the Control and Shift keys and clicking the Cancel button.

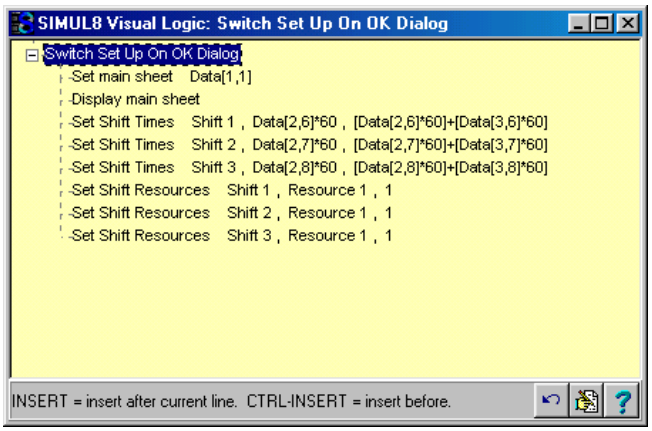
Visual Logic

Visual Logic can be used to control Components like any other aspect of **SIMUL8**.

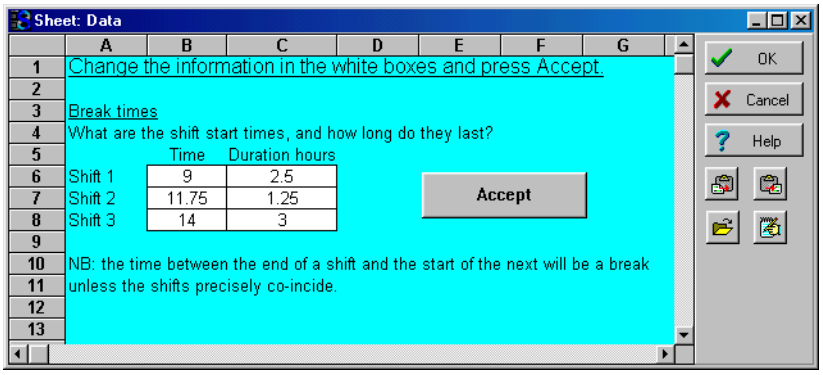
When attached to work center events, like Routing In or Out, it will operate as normal and be saved as part of the Component. Visual Logic is covered elsewhere in the **SIMUL8** manual and will not be covered in detail here.

The Visual Logic used in the Switch component supplied with **SIMUL8** can be copied and used in the Switch Test component that you have created.

The following routine is placed in the Dialog On Ok Visual Logic button


SIMUL8 Visual Logic: Switch Set Up On OK Dialog
Switch Set Up On OK Dialog
Set main sheet Data[1,1]
Display main sheet
Set Shift Times Shift 1 , Data[2,6]*60 , [Data[2,6]*60]+[Data[3,6]*60]
Set Shift Times Shift 2 , Data[2,7]*60 , [Data[2,7]*60]+[Data[3,7]*60]
Set Shift Times Shift 3 , Data[2,8]*60 , [Data[2,8]*60]+[Data[3,8]*60]
Set Shift Resources Shift 1 , Resource 1 , 1
Set Shift Resources Shift 2 , Resource 1 , 1
Set Shift Resources Shift 3 , Resource 1 , 1
INSERT = insert after current line. CTRL-INSERT = insert before.

This routine opens a **SIMUL8** spreadsheet called Data:



and then references the cells contained within.

The Accept button closes the spreadsheet and is optional.

Renaming Conventions

When a Component is placed in a simulation it checks if any items are present that have the same name. The items that share a name with an existing item are renamed, so if a component that contains WC1 is placed into a simulation that already contains WC1, the object inside the Component is renamed WC2.

Public and Private items

If a component contains Labels or Visual Logic code certain elements may be "Private" and for use in the Component only, other items may be "Public", and used elsewhere in the simulation.

By default Distribution names, Labels, and Global Data Items are considered to be Public, and are not renamed when a Component is created.

On occasions this will not be desirable. To allow Distributions names, Labels, and Global Data Items to be Private the text Private_ should be added to the name.

This means that Label1 will be used each time a component is created or copied, and Private_Label1 will be renamed Private_Label2 if the component is copied or used twice in the same simulation.

This structure allows separate Distributions to be used in otherwise identical components, Labels to be used to identify which instance of a component an item came form, and Global Data Items used to collect separate results for copies of otherwise identical components.

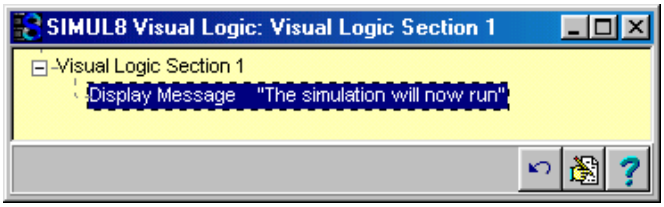
Component Events

NB Events in this case means when something happens to he simulation file. For example: the file is opened; the run button is pressed; the simulation ends.

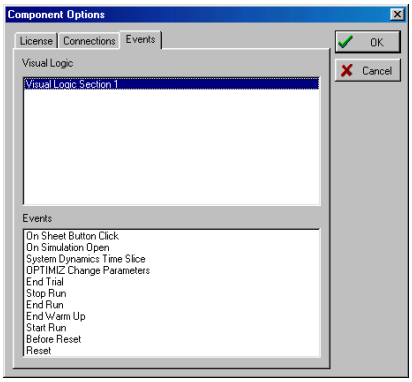
Although Visual Logic used in Work Centers and other objects is saved automatically , certain types of Visual Logic must be dealt with differently. For example Time Check or Start Run Visual Logic does not naturally exist as part of a component so must be dealt with in a different way

In the Component Options, Events tab, Visual Logic routines can be attached to **SIMUL8** events.

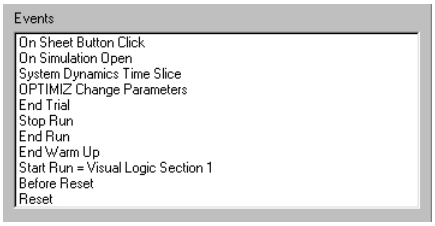
Write the following code using the Tools, Visual Logic, New option:



Create a Component and select the Component Options button and then the Events Tab.
The screen should show:



Drag and drop "Visual Logic Section 1" to the Events panel.
Drop it on the Start Run option:



Time Check Visual Logic:

Time Check Visual Logic is not listed as and Event.

Why?
Different Components in the same simulation can need different rules to run at different times. For maximum flexibility **SIMUL8** *creates events that can reschedule themselves.*
What does that mean?
Say you have a line of code that makes a message box pop up and display the current simulation time. It does this first at time 0, when the simulation starts, and every 60 minutes after. Time Check Logic will do this but in Components you need to use something else.
So: at Time 0 display the message and SCHEDULE the next message box to pop up 60 minutes later. At time 60 again display the box and schedule another message box at time 120 and so on.

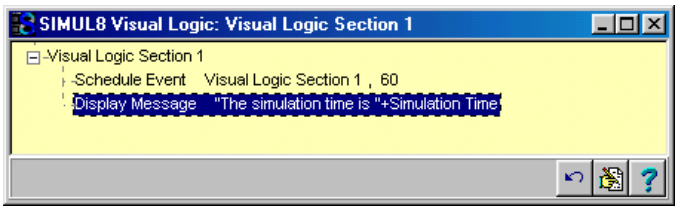
To recreate Time Check use the Schedule Event Visual Logic command. This command specifies a time that a piece of Visual Logic will run. Visual Logic can reschedule itself, effectively recreating the functionality of Time Check.

Schedule Next Event can be used in many different places for many purposes. So you can have as many Time Check equivalent pieces of Logic running as you need.

Tutorial 5: Schedule Event.

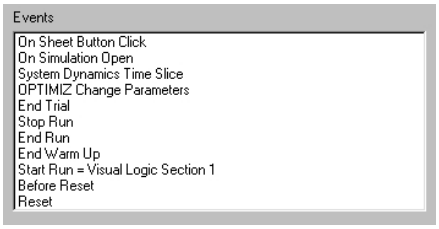
This Tutorial will show how to create a Visual Logic routine that runs at set time intervals.

Create a Visual Logic routine as shown below. Us the Tools Visual Logic, New option.

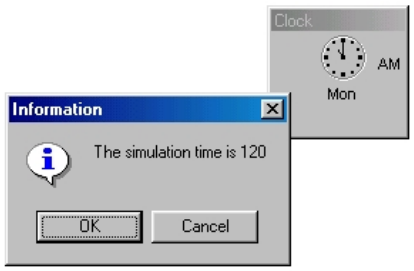

SIMUL8 Visual Logic: Visual Logic Section 1
Visual Logic Section 1
Schedule Event Visual Logic Section 1 , 60
Display Message "The simulation time is "+Simulation Time

This routine will display on a message box the Simulation time once every 60 time units.

Next, Create a Component and attach the Routine to the Start Run logic.



Now Run the model. You should see a message box that pops up once per hour, starting at the simulation start time (time 0).



In this example the simulation starts at 9am (time 0). The message box will
Pop-up at time 60 (10am), 120 (11am) and every 60 minutes thereafter.

SIMUL8 COM Extension

SIMUL8's API (OLE Automation/COM/ActiveX interface)

This is a standard Windows COM interface that allows any application that can use COM to drive SIMUL8 without user intervention.

There are two different levels of COM functionality available with SIMUL8.

1) SIMUL8 Standard Edition

A COM interface that allows basic operation of SIMUL8 including opening and running simulations, running trials, extracting results etc. Both .S8 and .XML simulation files are supported

2) SIMUL8 Professional Edition COM Interface (or SIMUL8 Standard plus the SIMUL8 COM Plug-In)

All of 1 plus the functionality to change simulation programmatically (for example by creating and linking simulation objects in the same way as can be done from SIMUL8's own internal Visual Logic.

(Note that SIMUL8 also supports an older style DDE/DLL interface that continues to work for back compatibility with old implementations. SIMUL8 V7 also supports a COM interface created for a few specific applications. This older COM interface is now not visible in most applications, but continues to work for back compatibility. It should not be used for new applications. Only the COM interface documented here should be used for most applications)

The remainder of this document is a step by step guide to using SIMUL8 Standard's COM interface.

It assumes no previous knowledge of COM or VBA but does assume some understanding of the use of Excel (note: Any COM-compatible language can be used, VBA is used here for example purposes because it is widely available (inside Excel). No recommendation should be implied from its use here and SIMUL8 Corporation's support team is not available to handle Visual Basic questions! - but we will help you with this example and the COM interface, and various languages use of the COM interface).

You must be using SIMUL8 V7 Build 147 or higher. If you don't have this download it from http://www.SIMUL8.com/upgrades (and follow links for free upgrades for existing V7 owners).

The example used here is included with this build (examples\api\com\example1.xls) but we recommend you build it yourself because there are key steps to learn in checking boxes in VBA.

In this example we use a standard S8 file and we assume you have installed SIMUL8 in the default directory. However XML files can be used *with the advantage that their content can be changed under program control* (by reading and writing the file to, for example, change values of variables).

COM Step by Step getting started guide

1) Open Excel with a blank spreadsheet
2) Open the CONTROL TOOLBOX toolbar (click RIGHT on any toolbar and check the CONTROL TOOLBOX option)
3) From this toolbar select a button and drag a rectangle on the spreadsheet to create a button (don't cover column A because we will use it later).
4) Double click the new button and you will see VBA open and place some empty code on the screen

5) In the menu on the VBA window click Tools/References

6) Find and check SIMUL8 Library

7) Click OK. Excel's VBA can now help and prompt you to get the syntax right when using SIMUL8's COM/ActiveX interface.
8) In the code window move the cursor up above the "Private Sub" line and type:

```
Private WithEvents MYSIMUL8 As SIMUL8.S8Simulation
```

We are now going to make the button open SIMUL8

9) Inside the code for the button click type:

```
Set MYSIMUL8 = GetObject("", "SIMUL8.S8Simulation")
```

Note that the "Set" keyword is NOT optional here (in most VBA it is optional - but NOT here!)

10) ALT-TAB to the main part of EXCEL.

11) Save the file.
12) Close the file
13) Reopen the file, and tell Excel to Enable Macros (otherwise your button will not work)

14) Click the button and SIMUL8 will start. DO NOT attempt to close SIMUL8 from the SIMUL8 Screen (Because it is not in control, Excel is)
15) ALT-TAB back to Excel
16) Use Tools/Macros/Visual Basic Editor to redisplay the VBA screen and click the RESET button. This stops your macros and closes SIMUL8 (we will next create a button to do this neatly.)
17) Use the CONTROL TOOLBOX toolbar again to put a second button on the screen, double click it and enter this code:

```
Private Sub CommandButton2_Click()
  MYSIMUL8.Open "c:\program files\simul8\examples\others\demo2.s8"
  MYSIMUL8.RunSim 2400
End Sub
```

18) Put a 3rd button on the screen with this code:

```
Private Sub CommandButton3_Click()
  Set MYSIMUL8 = Nothing
End Sub
```

so we can close SIMUL8, when we want to, from Excel (again, the SET keyword is important)

19) Switch out of Design Mode so you can use the buttons

20) Click each button in turn to Open SIMUL8, Open a model and run it, Close SIMUL8.
21) Next we will add an "Event" to your VBA so you know when the simulation run has finished and you can display some results
22) Go back to the VBA screen and select MYSIMUL8 in the left had drop down box.

23) In the right drop down box select S8SimulationEndRun and this code will appear:

```
Private Sub MYSIMUL8_S8SimulationEndRun()
End Sub
```

24) Add these 3 extra lines:

```
Private Sub MYSIMUL8_S8SimulationEndRun()
  For n = 1 To MYSIMUL8.ResultsCount
    Worksheets("Sheet1").Cells(n, 1).Value = MYSIMUL8.Results(n).Value
  Next n
End Sub
```

At the end of the run SIMUL8 will tell Excel the run has finished. Excel them loops through all the results on the results summary and adds the results into the cells in column 1 on sheet 1.

25) Go back to Excel, click button 1, then 2, then wait for SIMUL8 to finish the run. The results will appear once the run is complete.

26) Now click button 3 to close SIMUL8.

27) Try out the other methods and properties listed in the SIMUL8 COM Object Model reference over the page.

28) Finally, one helpful hint:

If you don't want to see SIMUL8 running put the line:

MYSIMUL8.Visible = False

after the
Set MYSIMUL8 = GetObject("", "SIMUL8.S8Simulation")
Line

Object Model Reference

This reference section documents only the COM objects available to SIMUL8 Standard users. Other COM objects and there interfaces are visible to SIMUL8 Standard users for reasons of COM compatibility across SIMUL8 versions, but they will not work or will return null values (for example SIMUL8.S8Simulation.SimObjectCount will return zero however many simulation objects are in the open simulation.

SIMUL8				
S8Simulation				
	Methods			
	Open	Filename(string)		Closes any open files and opens a new .S8 or .XML file
	Save	Filename(string)		Saves the currently open simulation as FileName
	Close			Closes any open files
	RunSim	EndTime (double)		Runs the simulation to time EndTime
	ReSetSim	RNS (integer)		Resets the time to zero and selects random number set RNS (0=no change)
	TrialSim	Runs (integer)	DisplayResults (boolean)	Runs a trial of "Runs" number of runs and displays the results summary if DisplayResults is true
	Properties			
	WarmUpTime	double		As the SIMUL8 internal

				Visual Logic variable of similar name
	SimulationTime	double		As the SIMUL8 internal Visual Logic variable of similar name
	FileName	string		Name of currently open simulation file
	Visible	boolean		Is SIMUL8 Visible to user (or running in background=false)
	ResultsCount	integer		Number of entries in the SIMUL8 Results Summary
	Results[n]	array of S8Result		Object for each result on the results summary
	Events			
	S8SimulationReset			The simulation has been reset to time zero
	S8SimulationEndRun			A run has been completed (received N times for a trial of N runs)
	S8SimulationOpened			A new simulation file has been opened
	S8SimulationCustom Event	TextInfo (string)		Can be created at any time from Visual Logic using Call COM Event
S8Result				
	Methods			
	Properties			
	Name	string		The full text for the name of the object and description on the left two columns of

				the SIMUL8 Results Summary Window
	SimObjectName	string		The name of the simulation object the result comes from
	Description	string		The text in the second column of the results summary
	IsDecision	boolean		True if the results summary item is not a result but a decision variable (see OPTIMIZ and OptQuest for SIMUL8)
	Value	double		The value of the result for the current run
	Mean	double		The mean of the result for the current trial
	ConfLimit [Percent as integer]	double		The statistical confidence limits around the mean. Only valid values of Percent are -99,-95,95,99.

Technical Examples

The following technical example models are all installed to your hard disk when you run the SETUP program on the SIMUL8 distribution disk 1. They are installed in the directory which you specify during the setup procedure.

ATACTION	Label Actions and Routing.
ATTDIST	Shows how a work center can use different distributions for different work items
BATCH	Batched Arrivals of Work to do.
BOTTLES	Shows the use on non-standard icons for products (on a stream of conveyors).
CLOSEQ	Shows the use of breakdowns which do not stop a work center until a storage bin is empty.
EXAMPLE2	An example of paper work flows.
LOOP	Shows how you can run a model of a contained system which does not have any "Work Starts" or "Work Completes" Objects and which uses Storage with some Initial Contents.
PRDCOUNT	Shows how to use Visual Basic to tell one work center to stop working when another has done a certain amount of work.
PRIWRKC	Priority for a work center in using labor (resources). The four machines in the center of the screen each require one unit of labor to operate. Only three units of labor are available.
PRIQ	Certain work items are given priority (in a queue) by using a label on the work items to sequence them in the queue.
TIMEDD	Illustrates how to use Time Dependent Distributions

Installation Guide

Standard Windows Installation

To install **SIMUL8** on your computer proceed as follows:

Place **SIMUL8** CD into your computer's CD drive.

In WINDOWS 95 or NT 4

CD will autostart.

If CD does not autostart then run SETUP on the CD drive.

Read the instructions on the screen. These will take you step-by-step through the installation process.

You will be able to choose the location where **SIMUL8** is stored on your hard disk.

SIMUL8 requires about 40MB of hard disk space.

Once installation is complete run **SIMUL8** by double clicking the **SIMUL8** icon on the desktop or by clicking the START button and choosing Program Files / SIMUL8 / SIMUL8.

Choose Help / Getting Started to run the tutorial learn how to build your own models.

> If you have any difficulty please call us for support. We want you to enjoy using **SIMUL8** to improve your business. See the front of this manual for contact information.

Network Installation

This information is provided for network administrators on setting up **SIMUL8** to run on a network.

Remember you must have enough licenses to cover the maximum number of computers which could possibly run **SIMUL8** simultaneously.

SIMUL8 can be installed from a network drive. Copy all the disks to the same directory on the network and then replace that network drive/directory name in the above instructions where you see "A:\".

Once you have installed **SIMUL8**, if it is installed in a shared directory you are advised to write-protect the files in the **SIMUL8** directory and its sub-directories. This enables all users to access copies of examples (and other files) which will not have been accidentally changed by other users.

If the directory containing the EXE and DLL files for **SIMUL8** is write protected when users are running **SIMUL8** then you should ensure the INI file (S8.INI in the same directory as S8.EXE):

DOES NOT contain any lines which start FILE?=

(These will be added if you should run **SIMUL8** while the directory is NOT write protected)

DOES CONTAIN a line (in the [STARTUP] section):

RunNumber=20

SIMUL8 has been designed to work well from shared network directories.

Support contact information is provided in the front of this manual. The web site contains a support forum.

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